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A Concrete Number

ON account of the meeting next week of the American Concrete Institute and the holding of the Chicago Cement Show, special attention has been given in this issue to matters of interest to designers and builders of concrete work. Most notable is the second of Mr. Johnson's articles on the use of the microscope in the study of concrete. Following that are articles on the economic design of concrete slabs, on a reinforced concrete roundhouse and on a low dam, so designed that its height may be increased. Two articles devoted to bridges are of a radically different character. One describes a double-deck concrete viaduct at Kansas City, having a length of half a mile and a maximum height of 100 ft. The other is a very suggestive article on separately molded bridges for railroad overcrossings. The articles form a notable group, including, as they do, design and construction, theoretical considerations, as in the article on slab design, and finally, through Mr. Johnson's article, opening up a vision of possible epoch-making developments in the use of concrete.

The Engineering Foundation

WITH appropriate ceremony the Engineering Foundation was inaugurated last week. It is pregnant with possibilities; what it will bring forth only the future can tell. With only its initial endowment it would be able to do excellent, though limited, work, but with his accustomed modesty the donor of the initial fund stipulated that his name should not be attached to the foundation, thereby making it possible for others to contribute. Without a doubt other gifts will come, and with them the possibilities of the foundation will be expanded.

Investigation—Then Action

THUS far the lines of activity of the foundation are undetermined, save that they are to make for the advancement of engineering and the welfare of mankind. Those purposes, expressed by the founder, do not necessarily imply that research work will be conducted, but it is likely that it will be undertaken. No reflection is needed to assent to the statement that there are many lines in which careful study will be amply repaid, but the Engineering Record submits to the Engineering Foundation Board that before action should come investigation, and before new work a survey of the field. Much engineering research is under way, each particular undertaking being planned wisely or not according to the reference resources of the investigator and his diligence in inquiring as to whether

similar work has been done. If there were a clearing house of industrial and engineering research, where results could be deposited and information obtained, there would be great economy in energy devoted to research work. Manifestly the whole field of engineering could not be covered, but several important lines might be attacked at once. While, under this plan, the foundation would not immediately through its own studies make extraordinary discoveries, it would, nevertheless, be fulfilling its mission of working for the advancement of engineering and the welfare of mankind.

Co-operation Among Societies

INTERESTING indeed was the declaration last week at the inauguration of the Engineering Foundation that the co-operation of the American Society of Civil Engineers in that work marked the repair of a breach between that organization and the other national engineering societies dating from the proposal to erect the United Societies Building. Just how wide the breach or what the reasons is not now pertinent. What is pertinent is that, if Capt. Robert W. Hunt and Gano Dunn be correct, co-operation of a more hearty sort than in the past may be expected between the four great national engineering bodies. There is need for closer relations if engineers are to exercise an influence upon those public affairs in which their special knowledge is necessary for the formulation of correct policies. Until there is co-operation, engineers will not occupy the position that is theirs by right and duty.

New Features in Crib Design

LACK of space prevented comment in the issue of Jan. 23 on the type of crib to be used on the Wilson Avenue tunnel described in that issue. It is of a sort new to Chicago, consisting virtually of a steel cofferdam, made up of two concentric shells with open top and bottom, buoyed up by bulkheading the ports and by special flotation cylinders. The space between the shells will ultimately be filled with concrete after the base has been floated to place and sunk over the tunnel-shaft site. It is expected that the shell will sink deep enough into the clay to allow it to be pumped out, thereby allowing the shaft to be excavated in the dry. However, if necessary, provision has been made for the construction of the shaft through the water by the use of cast-iron cylinders. Another radical departure in intake design is the omission of gates. If it be desired to pump out the shaft, the stop-logs can be placed in the screen guides. Operation of crib gates

is seldom necessary. Their first cost and the maintenance of the operating equipment is considerable, so that their omission simplifies the design very materially. Waterworks engineers having to do with lake intakes will be interested in the results achieved with these two innovations.

Preaching

A TECHNICAL club in Chicago has recently sent an apology to its members for a "risque" story told at its annual dinner some weeks ago. One of the Chicago papers, hearing of the incident, commented approvingly on this evidence of a change in the moral tone of "stag" dinners. The Engineering Record says "Amen," and passes the thought to those in charge of the dinners of engineering, contracting and commercial organizations. That a change of point of view was needed wants no proof. At the dinner of the American Highway Association in Atlanta last November a succession of salacious stories, told by men of national as well as of local reputation, received the hearty approval of 500 otherwise respectable guests. Strange it is that men who revolt at physical filth will en masse delight in moral slime.

Evidence of the Microscope

IN THIS issue is presented the second of Mr. Johnson's series of articles on the microscopic examination of concrete. That there have been failures of underwater concretes is incontestable, but there has been a wide divergence of opinion among concrete engineers as to the real causes for these failures. It has been customary to hold the cement at fault, but by the researches set forth in this article, this burden of responsibility, while not wholly removed from the cement, is at least shared with other portions of the mixture. The discussion emphasizes the fact that mass perfection is dependent upon unit perfection and that the seemingly insignificant detail may, in the end, prove most important. Nor should it be objected that a demonstration, such as this, is "destructive criticism." Rather is it constructive, for the conditions it portrays, although unknown, have existed and do exist in concretes. Bringing them to light is, of itself, a distinct constructive step, even were remedies not suggested and demonstrated, as will be done in this case, in later articles. The first step is to realize fully the causative. The remedial soon follows. Necessarily, proof of all statements made, as for instance, that certain structures are groups of unhydrated cement, must, for lack of present space, be deferred until later articles. As speedily as possible, however,

these will be taken up and proof advanced for the statements made. For the present, it is asked that they be accepted at face value.

The Concrete Institute

NEXT week the American Concrete Institute holds its annual convention. Those who have been in close touch with its activities have high hopes that this is the turning point in its history. Once a virile, progressive association, it has dwindled to a mere shadow of its former self. Last year's meeting was lifeless, bearing no resemblance to the stimulating sessions of earlier years. A new spirit, if not an entire new personnel, is about to take hold. The start has been made by selecting for secretary a gentleman apparently well qualified for the development work needed. This step will be followed next week by advancing to the presidency one of the present officers, an engineer who has brought a large business to mark success. The organization has an excellent *raison d'être*, but it can survive only by adopting aggressive, businesslike methods. Much of the work that the institute might have done has been assumed by the publicity and information bureaus of cement companies and the association of cement manufacturers, but a management with imagination, resourcefulness and familiarity with publicity methods can regain much ground and discover new opportunities for service. The best wishes of everyone interested in concrete will go with the new régime, the while ample credit for their devotion will be given the retiring officers.

A "Practical Man" Rampant

IF a caucus of officials-elect in Honolulu has been reported correctly by the local press, it is clear that a strenuous campaign of education is needed to readjust existing impressions as to the proper scope of the engineer's work in road building. A supervisor-elect, so the newspaper report indicates, takes it upon himself to outline the engineer's duties. Apparently he is a "practical man," so that his words of wisdom should not pass unheeded. "What does an engineer," he says, "know about road building? Road building is a business, not a profession. The engineer should have nothing to say about what kind of roads are built or where they should be built. All that should be required of him is to give the grades and subgrades—or do whatever technical work is necessary—and let the supervisors go ahead with the rest." To anyone who appreciates the technical knowledge needed in the selection of the proper type of road and its construction, the supervisor's remarks appear, at first, merely ludicrous. But it must be remembered that few laymen know anything about the details of the engineer's work and, therefore, that such absurdities, coming from a man in an official capacity, no matter what that capacity may be, are given undue weight by the public and do incalculable harm. The supervisor's idea of an engineer is a

man who squints through a transit and drives grade stakes. It there be an organization of engineers in Honolulu, its clear duty is to change the opinion of the profession held by the supervisor-elect and let the public, which is paying the bills, know what are the true functions of the engineer.

An Employers' Bill of Rights

IN the course of a decision rendered last week the Supreme Court announced what is in effect an employers' bill of rights. This was incidental to the main question the court was called upon to decide, which was the constitutionality of the Kansas statute making it unlawful to coerce or influence a person to enter into an agreement not to join or remain a member of labor organizations as a condition of obtaining or continuing employment. The court decided that this law is unconstitutional and with the Kansas statute there falls to the ground similar laws in a dozen other states, including California, Colorado, Connecticut, Indiana, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Oklahoma, Oregon, Pennsylvania, and Wisconsin. Employers in the states named as well as in others may take notice that the renunciation of union affiliations may legally be made a condition of employment.

The decision is important enough as it stands, but even more important than the point actually decided is the declaration of Justice Pitney in the prevailing decision of the respective rights of employers and employees. So successful has been the propaganda of trades unionists to establish a wholly one-sided view of labor contracts that it was time popular ideas on this subject should be clarified. This Justice Pitney has done admirably in the paragraph in which he says:

"Just as labor organizations have the inherent and constitutional right to deny membership to any man who will not agree that during such membership he will not accept or retain employment in company with non-union men, and just as a union man has the constitutional right to decline proffered employment unless the employer will agree not to employ any non-union man, so the employer has the constitutional right to insist that the employee shall refrain from affiliation with the union during the term of the employment."

To ask a man to refrain from or give up union affiliations as a condition of employment is not, the court declares, to require him to give up any part of his constitutional freedom. In essence the trades-union theory has been that the employee had a right to control what the employer should do, while the employer had no right to place similar or even equal restrictions upon the employee. The Supreme Court says that there is nothing in this claim. In doing so the court has affirmed a former decision declaring unconstitutional a Federal statute forbidding the discharge of an employee of an interstate railway because he belonged to a

union. The decision in the Kansas case merely restates the court's position, but that it needed restatement is shown, among other things, by the fact that so many states attempted to do what the court had said the Federal Government could not do.

The Airship Raids

THOSE who have been following the remarkable developments of aerial craft during the present war have been awaiting with interest the possible effect upon England of a raid by Zeppelins, which from time to time was predicted with blood-curdling asseverations as to the dreadful things that were about to happen. The first raid occurred recently, since, if the quasi-official communications and reports are to be trusted, three or four airships, presumably of the Zeppelin type, on account of the long radius of action required, constituted the marauding force. "The great aerial war monsters," to quote their reportorial title, came from the North Sea in a dark and hazy night and cruised along the Norfolk coast for a couple of hours, scattering bombs promiscuously, with a specially friendly effort at destroying Sandringham, where the admirable spy system had led them to suppose the royal family was housed.

From the standpoint of engineering it is somewhat interesting to consider what was really accomplished. Reports indicate that five or six persons were killed and as many wounded, several roofs damaged, a few little houses badly smashed and a great deal of glass broken during the two hours before the airships again put out over the sea. This is not a large showing for an attack by several 500-ft. Zeppelins, alleged to carry tons of mysterious explosive of unexampled power. The only thing really demonstrated by the raid was that the British, despite the lurid threats of such a raid, had not guarded the coast with any approach to thoroughness. There seems to have been insufficient searchlight equipment to pick up the assailants and no guns for high-angle fire to bring them down, to say nothing of the absence of defending aeroplanes.

Briefly, the German raiders caught the British napping and in spite of this accomplished extremely little. The meager results show plainly that, valuable as the airship is as an adjunct in military operations, it has shown as yet very few signs of being an offensive weapon of importance. In order to keep out of gun range an airship has to cruise at what is practically her utmost height. Indeed it is very doubtful whether the Zeppelins can get out of range of properly mounted artillery, and from such height, or in utter darkness from a somewhat lower plane, the throwing of bombs with precision is not easy. The way of the ship and the effect of wind makes aiming uncertain even by daylight, and at night bombs thrown into the darkness are fired almost at random.

To the engineer the most interesting feature of the attack is the demonstration

of long-distance raiding, and the question of greatest importance is the starting point of the German fleet. The long radius of action of the German airships has been well known, yet it is hardly likely that in this case the start was made from clear across the North Sea. What few reports are available would tend to indicate that the ships skirted the coast from Heligoland or Emden, following the Frisian Islands westward and then turning sharply across the North Sea, hardly more than a three-hours flight to their destination. Had they started from Belgium, London would have been a more probable destination, although involving much greater risk.

However this may be, the raid has been made, the airships, thanks to darkness and British unpreparedness, got in and got away unharmed and the amount of injury done, except to the nerves of timid civilians, has been of remarkably small account. It must be reassuring to know that the land was not laid waste as per schedule, nor were the British Isles in any risk of being blown off the map. Whatever may be the ultimate efficiency of aerial tactics the demonstrations up to the present have certainly not been convincing.

Mental Attitude of Research Bureau Workers

EFFECTIVE results from municipal research bureaus depend upon many factors, none of which is more important than co-operation between the investigators and the departments under scrutiny. The time-honored unpopularity of the tax gatherer has in a sense descended upon the shoulders of the so-called efficiency specialist, and success in the difficult tasks of the latter demands tact and ability in about equal proportions. Lacking the former, antagonism is sure to develop early in the proceedings, and without the latter, many real betterments are certain to be lost.

This work is one from which inexperienced men had better be barred, and in which a deep sense of responsibility needs to be maintained. To organize a city research bureau with a staff of young "A. B.'s" fresh from "Economics 47," with no harder experience in life than comes from "plugging" for semi-annual examinations is to invite disaster. There is no question that many a bright young man recently graduated from college or from an engineering school can go into the street department or the sewer department and find some feature of administration which looks out of harmony with the latest ideas of the efficiency student, but that does not qualify him to pass judgment on the organization as a whole. The department head worthy of his position welcomes honest criticism, but the danger in a research bureau manned by investigators without a proper perspective is that they will overlook practically all the commendable features of the departmental work and appear to be actuated by a desire "to show up somebody" instead of to be constructively helpful. Worse than this, they sometimes make erroneous reports, even

after being shown the real state of affairs, and the temptation to found criticisms upon inadequate data, on account of lack of time and because of the difficulties of mastering complex administrative problems, is very serious.

Entire frankness in discussing points of apparent low efficiency, a sound comprehension of the broader technical principles controlling the work of each department, willingness to drop a line of suggestion if shown its inapplicability to local conditions, a friendly and sympathetic attitude on a man-to-man basis in dealing with department heads educated in the hard school of experience, and a desire to save the municipality money by constructive co-operation wherever possible in preference to attaining results by attacks in the form of private reports whose context is unfamiliar to the department heads concerned are some of the features of a successful efficiency bureau's policy. Experience and the willingness to learn something from the humblest employee go a long way toward preparing one for service in this arduous field, which may be made to yield a valuable harvest when the good of the municipality is placed above personal aggrandizement.

The New Knowledge of Coal

TO many engineers the determination of the calorific power of coal in the laboratory and the analysis of flue gases represent the most advanced outposts in the study of this chief of fuels. The scientific study of coal has gone far beyond the calorimeter and the sample tube, however, and while the latest investigations are rendered difficult by the extreme complexity of the chemical constituents of coal, substantial advances are being recorded, notably in the study of volatilization, spontaneous combustion, yield of by-products of carbonization, and other aspects of the use of fuel.

In a recent lecture at the University of Pittsburgh, Horace C. Porter, chemical engineer of the U. S. Bureau of Mines, pointed out that great opportunities for the scientific utilization of coal exist in connection with the coke oven or gas retort for the coal-tar by-products, of which a greatly increased demand has been created by the European war. Sufficient coal tar and benzol can be produced from existing by-product coke ovens and gas retorts to supply the present American demand for coal-tar products, creosote oil being excepted. Low or medium-temperature carbonization of coal is being successfully used to recover oils, possibly motor fuels, from coals not heretofore commonly employed for by-products, and it is considered likely that coke-oven central stations will come into vogue for electric power transmission as an outcome of the increasing value of by-products, the development of the gas engine, the successful use of coke as a domestic and industrial fuel and the growth of public opposition to the smoke nuisance. In view of the wonderful development of the steam turbine in the past decade, the realization of the foregoing can hardly be said to be

close at hand commercially, but movements in this direction will bear watching, since the scientific study of coal is today very largely centered upon volatilization.

The investigator who would penetrate to the very heart of the fuel problem must qualify as an organic chemist. Out of profound researches into the composition of coal are coming results of general engineering interest. Many misconceptions in regard to the volatile products of combustion are being cleared up. Thus there is probably little or no material in coal which is volatile without decomposition, and from one-eighth to one-half the volatile matter of coal is non-combustible, a point of importance in comparing coals, since those having rich, smoky, volatile matter are more difficult to burn efficiently than others having a volatile component possibly greater in amount but with a larger proportion of inert matter. The composition of what is called "volatile matter" in reality depends upon the temperature to which the coal and its primary products of decomposition are subjected as well as upon the kind of fuel involved.

The importance of minimizing fuel losses due to spontaneous combustion has led to extended studies of oxidation and ignition. Recent laboratory tests have shown a wide variation among different coals and other combustible substances in their rate of oxidation, and the variation in this property follows the known variations in ease of ignition, in susceptibility to spontaneous combustion, and in rate of deterioration in storage. The action of oxygen on coal at ordinary temperatures has been shown recently to consist not of a burning of the carbon to carbon dioxide nor probably of a burning of hydrogen to water, but largely of an addition of oxygen to the coal substance. English investigators have shown that this action at 40 deg. C. amounts to the liberation of nearly as many heat units per cubic centimeter of oxygen as when coal is completely burned. The rate of oxidation increases very rapidly with rise of temperature; hence the importance of proper sizing and piling of coal in storage. Fine slack coal does not heat seriously in the interior of a pile if no lump is present to admit air, and the fire risk is greatest if the pile interior consists largely of fine coal and outer and lower sections mainly of lump.

Deterioration of coal in storage is now known to be due to oxidation, not to loss of volatile matter. It is not so great as has commonly been supposed, running only about 1 per cent loss in heating value with one year's exposure of high-grade bituminous and semi-bituminous fuels, and less than 3 per cent in five years. Even with Middle-Western coals or lignites the loss probably does not exceed 4 or 5 per cent in one year. Deterioration of any kind may be quite largely prevented by storage under water.

These are but a few of the phases of the coal question that are being investigated. Their value in fuel conservation and operating efficiency can scarcely be exaggerated.

Mechanical Disintegration of Defective Concretes

Second Article in Series of Six—Demonstrating Certain Disruptive Crystalline Actions, Which Have Their Inception in the Capillary Pores

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WHEN sea water, or even fresh water, is brought into contact with the cement matrix of concrete, solution to a greater or less extent adds new compounds of indefinite nature. When such waters are carried to the interior of a mass of concrete by the capillary action of minute pores, the limitations to quantity imposed by the size of the pores result in the production of super-saturated solutions of these dissolved materials. But super-saturated solutions speedily crystallize on reaching a certain density, with the result that there are exerted on the matrix of the concrete powerful disruptive stresses, the effects of which may readily be traced by means of the microscope. These stresses may even exceed the strength of the concrete, with the production of local disruptions which later become general. To differentiate these disruptions from other purely chemical actions that may cause the failure of concretes, they have been designated as "mechanical disintegrations"—a designation which, it is believed, the demonstrations of this paper will justify. These are some of the secondary effects attributable directly to the presence of entrained air in concrete, the primary effects of which were pointed out in the preceding article (issue of Jan. 23, page 98).

It should be understood that while these demonstrations are unusual and to a certain extent startling, they relate to defective concretes, and are quite without prejudice to the successful uses of concrete in sub-aqueous structures in all parts of the world. One of the primary objects of this research has been the production of concrete thoroughly capable of withstanding the action of waters which have heretofore caused trouble; and in any such quest it is essential that all of the actions involved should be thoroughly understood.

It is probable that many of the vexatious faults of concrete construction of all classes are due as much to physical as to chemical causes; and, secondarily, to a combination of physical and chemical causes. In sea-water construction, especially, it is probable that the defects which induce failure lie primarily not so much in the cement, providing cement of proper quality be used, as in the improper proportioning of aggregates, or in poor mixing, or in a combination of the two.

CONCRETES TO BE STUDIED

In Fig. 6 are given photomicrographs of the four concretes which are to be investigated with a view to determining causes of such failure. These photographs were taken at low power in order that as much of the surface as possible, the interrelation of aggregates, and, particularly, the prevalence of pores in the matrix might be made plain.

In interpreting these photographs, it should be remembered that all of the larger irregular white patches with dark borders are sand grains; that each of the black patches, or irregular black streaks, is a hole

or a deep crack, and that the white material between the sand grains is the matrix, of more or less hydrated cement. Is it not significant that no two of these sand grains are touching? And is it not significant also and confirmatory of what has before been said, that between the sand grains in every photograph lie smaller grains, too small to be sand? By using a higher magnification with the microscope, these latter can very easily be proved to be groups of unhydrated cement particles, a proof to be demonstrated fully and conclusively in the final article of this series.

PORES IN MATRIX

But the feature to which present attention is most strongly directed is the prevalence of black spots in the cement matrix. Each of these is a hole, or pore, of indefinite direction and extent. Further, as each photograph shows the features of a random section in a random specimen from the structure in question, it is probable that practically the whole of each of these structures is literally honeycombed by millions of tiny pores.

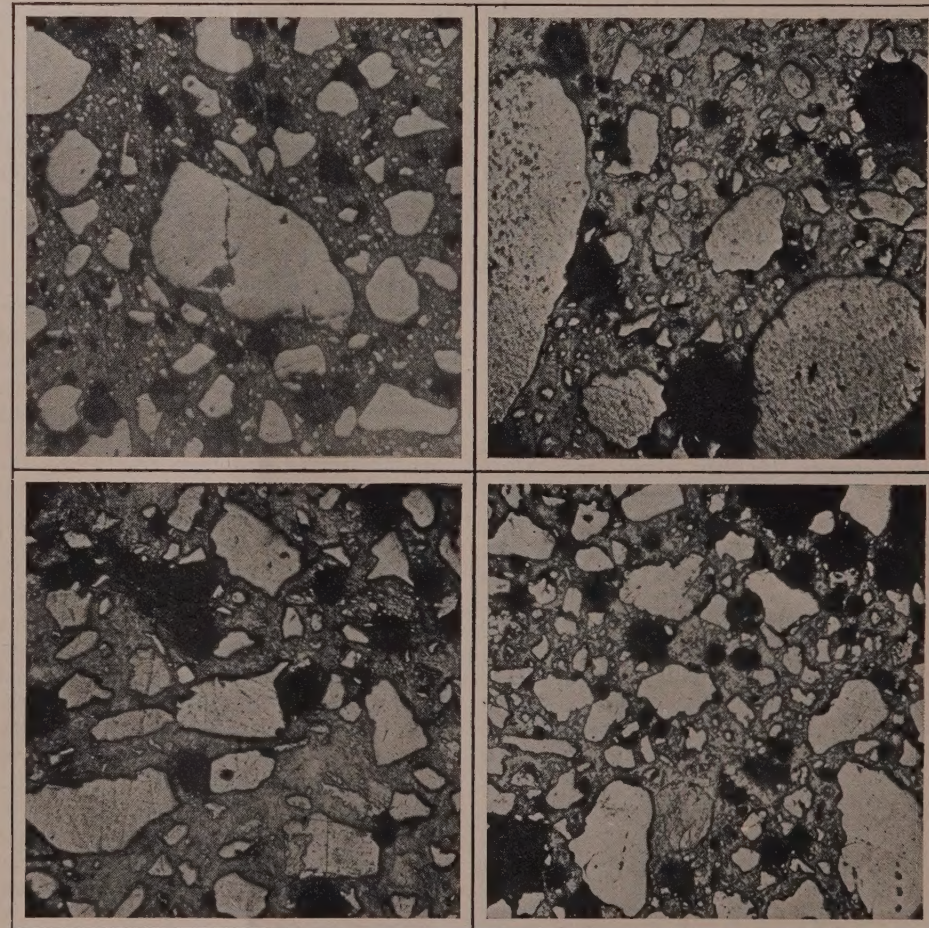
Although the presence of such pores in

concrete has long been known, it is a question whether or not their prevalence and the damage they may cause has been recognized. The seepage of water into pores and the disintegrating action of frost have been remarked by a number of observers, but so far as the writer is aware, the really serious extent to which such actions may operate has not been appreciated, the inferential assumption, at least, being that they are confined to surface layers. On the contrary, however, it seems probable that these actions operate beyond the surface layers, to a depth dependent upon the degree of porosity of the mass.

Such a statement requires rigid proof. As a first step toward it, consider what must be the state of affairs in a concrete as full of tiny pores as the concretes under examination would seem to be.

CAPILLARY ACTION

The phenomena of capillarity—exhibited, for instance, by a tube of hair-like diameter of bore, or by a lamp wick—are well known. The smaller the bore of the tube, or the closer the weave of the wick, within certain limits, the greater will be the

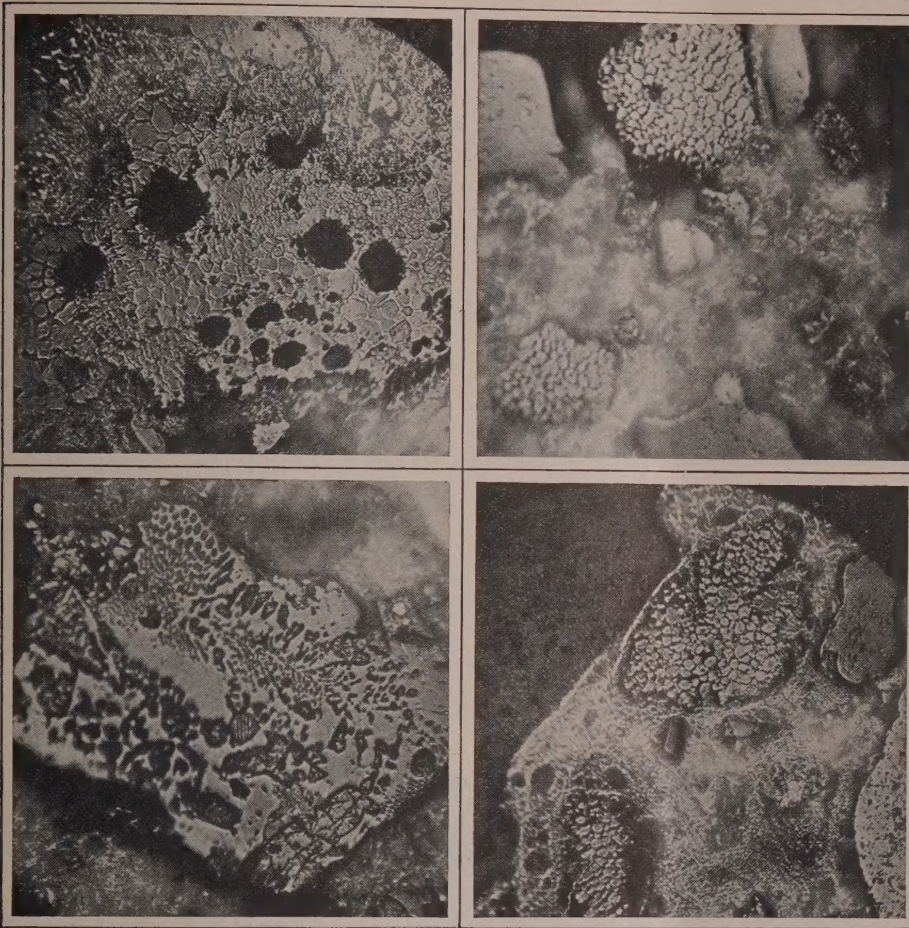


(a) Spillway of Dam, Ithaca, N. Y.
(c) Dock Wall, East River, New York.

(b) Pier at Atlantic City, N. J.
(d) Pile Cap, New York Harbor.

FIG. 6—INVESTIGATION OF THESE CONCRETES DISCUSSED IN THIS ARTICLE

Magnification, 20 diameters; black spots are holes



(a) Spillway of Dam, Ithaca, N. Y.
(c) Dock Wall, East River, New York.

(b) Pier at Atlantic City, N. J.
(d) Pile Cap, New York Harbor.

FIG. 7—UNHYDRATED CEMENT PARTICLES; MAGNIFICATION, 200 DIAMETERS

capillary effect and the higher will the liquid rise.

It is probable that the pores of the concretes under examination are all within the capillary range and well adapted to aid the entrance of liquids in the mass. Further, the phenomena of *absorption* and *adsorption* may aid such entrance, transferring the liquid through semi-solid barriers to other capillary passages beyond until the entire mass has become thoroughly permeated.

Under such conditions a number of disintegrating actions, in addition to that of frost, are possible. To take one of the most obvious, consider the results of contact between a strongly saline, sulphated water and steel reinforcement embedded in concrete. Of all natural waters, saline solutions are the most corrosive of iron and steel; and because of the progressive nature of such corrosion, a single point of attack soon results in the affection of a large area of the material. Ferrous sulphate and ferric chloride are formed, parts of which, in combination with the oxygen entrained in the concrete, or in the entrant water, break down into $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$, or common rust, with an enormous increase in bulk. Destruction of reinforcing steel is a sufficiently great evil, but when there is added to it the actual disruption of the concrete by which it is surrounded, collapse of the structure is to be expected. However, the existence of such action is dependent upon the continuity of the capillary pore and upon the existence of a point, or of points of attack, on the surface of the steel. Extended experiments along these lines show that where proper con-

tact is had between the cement and steel there is little liability to corrosion.

UNHYDRATED CEMENT

But although frost action and corrosion are often important factors in the success or failure of under-water concretes, other more obscure physico-chemical actions are

properly the subject of this present investigation. As in previous papers, the microscope will be used to furnish visual evidence in regard to doubtful or conjectural points. Abstruse chemical questions will be avoided, as far as possible, it being preferred herein to regard cement only as a physical material available for structural purposes, rather than as a chemical complex capable of giving certain reactions under specified conditions. Such problems as the latter are the province of the chemist, rather than of the engineer.

It was stated in the previous article that all concretes, regardless of age, contain a considerable percentage of unhydrated cement particles, usually in groups or lumps. Such groups are shown in Fig. 7, high-power photomicrographs of the four concretes whose general characteristics were shown in the low-power photographs of Fig. 6. Below the cut is given the approximate age of the concrete represented by the samples.

It will be seen that all the photographs exhibit the same characteristic group-structures. Especial attention is called to (c), Fig. 7, not only as an unusual photograph, but also because it shows a single particle of what is apparently cement clinker eutectic. Needless to say, this particle has remained quite unaffected by water, despite the passage of years, although the concrete from which was taken the sample in which this relatively large piece lies was placed under water 34 years ago, when fine-grinding was almost unheard of. This of itself is a very significant comment on the relative values of fine and coarse grinding. This is the only concrete so far examined by the writer in which so large a piece of clinker has been observed.

PART PLAYED BY UNHYDRATED CEMENT

It now becomes necessary to conjecture the part such lumps play in the matrix of partially hydrated or wholly hydrated and set cement lying between the aggregates, if water is later brought to them by capillary pores. Necessarily, these lumps form spots of low mechanical strength, but it

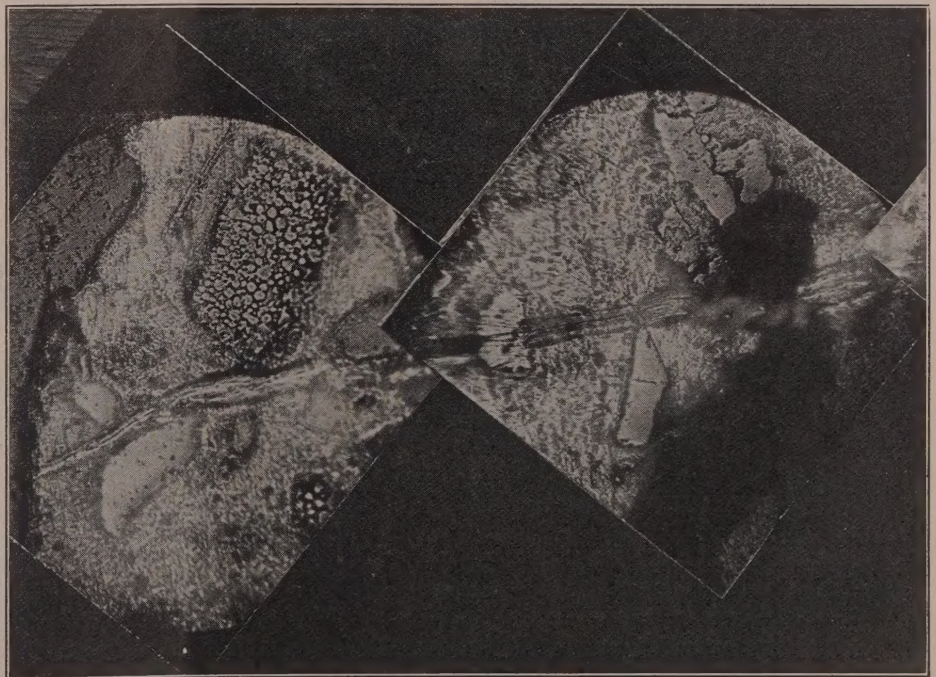


FIG. 8—"SHEAR PLANES" OR "STRAIN BANDS"; PILE CAP, NEW YORK HARBOR
Magnification, 200 diameters

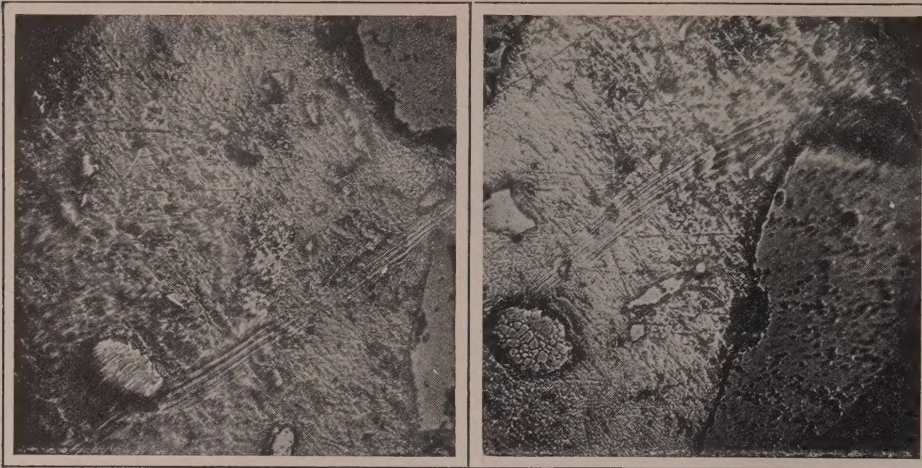


FIG. 9—FURTHER EXAMPLES OF "SHEAR PLANES" OR "STRAIN BANDS"

is possible in a defective concrete that such may be their least objectionable feature, for in that capacity they at least form an integral part of the rigid mass. But if hydration is brought about by the means above outlined, a new set of reactions is necessarily set up, with the formation in the very heart of the matrix of new compounds of uncertain nature and larger space-filling value. (H. S. Spackman, "Cement Age," August, 1908; Feret, "Annales des Ponts et Chaussées," 1892, II p. 93.) But if this action takes place, and if compounds are formed such that tremendous disruptive forces are exerted on the matrix, it may reasonably be expected that their effects can be detected even short of actual fracture. In the softer metals, such as babbitts, which in texture are not unlike the cement matrix of concrete, incipient failure leaves traces known as "shear planes," or "strain bands," which are very distinctive. In Fig. 8 are shown such "shear planes" in the cement matrix, with several unhydrated cement groups near by, in a proximity highly suggestive, if not wholly convincing. The pore in this instance may be the fissure at the side of the sand grain at the left. Fig. 9 shows two other such shear planes in another specimen.

ACTION OF SALTS CARRIED BY SEA WATER

This suggestion as to the origin of these shear planes is made tentatively. Their existence is known beyond doubt, but the nature or causes of the forces which gave rise to them is solely a matter of conjecture.

There are other physico-chemical actions, not attributable to the hydration of lumps of cement, which might, with equal probability, be responsible.

For instance, when a tiny pore has sucked up its fill of sea water, what becomes of that water? It can hardly be expected to remain *in situ* as so much sea water, until the end

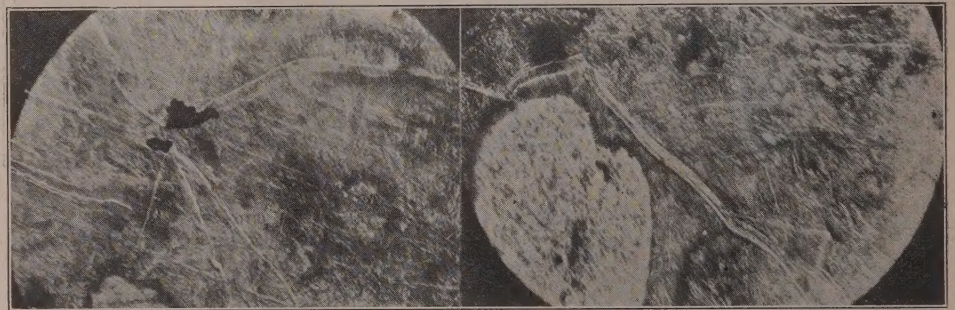


FIG. 10—MATRIX CRACKS RADIATING FROM A PORE; PIER AT ATLANTIC CITY

Magnification, 160 diameters

of time, for it is loaded with chemically-vigorous salts. Absorption and adsorption must affect it, both qualitatively and quantitatively. First of all, it dissolves as much as possible of the matter with which it is in contact. When saturated, it deposits in solid form, and possibly with increased bulk, the salts it holds in solution, generally with the result that the concrete in the vicinity is at least softened, if not wholly disintegrated. This softening is well known and has been often commented upon. (Taylor & Thomp-

son, "Concrete, Plain and Reinforced," page 310; H. S. Taft, "Cement & Engineering News," May, 1914, page 126; U. S. Bureau of Standards, Bulletin 12, page 100.)

In the progress of such an action, it is reasonable to expect that a pore would be the starting point of any disintegration. Such an expectation is justified. In Fig. 10 is shown a plane cut across a pore (indicated by the black spot); and radiating from this pore are *no less than six fractures*, with probably others in different planes which are not seen. The fractures can readily be traced because of their aimless wanderings, closely resembling creeping-cracks in a sheet of glass. It should be noted that these fractures are quite distinct from the polish scratches, which go straight across the photograph.

CRACKS REPRESENTATIVE, NOT UNUSUAL

If this were an isolated case, its value might very properly be questioned. On the contrary, it is highly characteristic and representative. Of all the very considerable number of defective concretes so far examined in the course of this research, whether submerged in fresh water, or in sea water *not one has failed to reveal the features of incipient disintegration here*

noted. Nor need the concrete be wholly submerged. Buttress walls exposed to ground seepage show these features to a marked degree. Magnify the actions indicated in Fig. 10 a few hundred times, and there is realized a condition of actual, visible disintegration similar to that shown in (a) Fig. 11, where the tiny fracture has become a large crack filled with crystalline matter that sticks out a quarter of an inch or more from the face of the wall. And in (b) of the same figure is made evident



FIG. 11—FRONT AND REAR OF DEFECTIVE BUTTRESS WALL AT PITSTON, PA., BEING DISRUPTED BY CRYSTALLINE DIKES

the cause of this disintegration. As can clearly be seen, this wall is but a shell of poorly compacted and almost uncemented stones, into which the ground water has the freest of access. No wonder that the grouted face shows evidence of the decayed body. Each failure results from determinable causes; and this case is but further evidence that in most instances the causes have their origin in the wilful abuse of good materials.

It is quite possible with the data already in hand, and with more accumulating daily, to multiply similar instances of incipient disintegration to a very considerable length, but two cases more should here suffice to bring home to engineers a realization of the actual existence and potency of crystalline action similar to those noted above.

PROGRESS OF CRYSTALLIZATION

In Fig. 12 is shown a long crystallizing deposit, or dike, radiating from a pore. The process of its formation is not hard to picture. In the beginning the pore sucked up the sea water, loaded with its various salts. In the manner before outlined, the water content was diminished, with resultant concentration of solution, until its dissolved salts crystallized, possibly while the concrete was yet comparatively new. Room had to be made for these crystals, so that a tiny fissure in the weakest material, i.e., the cement matrix, was formed. But surfaces close together, as were the sides of this fissure, act as do capillary pores, so that a fresh supply of water brought by the pore was sucked into this fissure, where its salts, in turn, crystallized, wedging the fissure yet further along and wider apart, with the formation, by repeated crystallization, of a hard dike of foreign material in the space thus provided. This process was repeated again and again, an indefinite number of times, until the supply of crystallizing salts was stopped in July last by the removal of the specimen from a beam beneath a pier at Atlantic City.

This dike, like all others of its kind, meanders through the matrix, *never crossing a piece of aggregate, but keeping to the weakest part of the concrete.* At the end near the pore, where the crack began and where the wedging was most often repeated, the dike is the widest. This portion shows black in the photograph, indicating a surface out of the focus of the microscope. The dike itself at this place and the crystals in the pore, have either been torn out in polishing, or have been dissolved out by too great supplies of fresh water, or they may have become loosened by drying and fallen out. In any event, they are gone, but the place where the dike lay is plainly seen. The rest of the crystalline filling stands out boldly, because it is stronger and harder than the matrix which it has crushed.

As stated before, this action is not necessarily confined to defective sea-water concretes. Fig. 13 shows two similar radiating dikes, with the beginning of a third, in a fresh water concrete of like nature. This latter dike may have stopped in the early stages, as the other two may have required all of the dissolved matter that the pore could furnish, or it may have dropped beneath the surface polished, or have risen above and been cut away in the grinding of the specimen. In any event, it has disappeared. It will be observed that these dikes meander as did the others, dodging the strong aggregate and keeping to the weak matrix. These conditions are probably duplicated a few million times in the structure from which this sample was obtained, as it is even now showing outward signs of the inward disintegration of which this is a type.

SUMMARY

Summarizing this article, it should be noted:

1. That concrete structures in which proper care has not been exercised in selecting aggregates, or in mixing and placing, are honeycombed by millions of pores of greater or less size, formed by the occlusion of air in the cement matrix.
2. That these pores are adapted to promote by capillary action the penetration of water below the surface layers.
3. That when water is brought by a capillary pore, aided by absorption, or adsorption, or both, into contact with a group or groups of the unhydrated cement particles that exist in all concrete, new reactions with new volumes are probably set up in the rigid matrix of set cement.
4. That these reactions may cause disruptive stress to be exerted on the cement matrix of the concrete, producing "shear planes" or "slip bands" as evidence of the local failure thus produced.
5. That "shear planes" and other evidences of local failure by disruption,

FIG. 12—DISRUPTIVE CRYSTALLINE DIKE IN CONCRETE OF PIER, ATLANTIC CITY; RUNS THROUGH MATRIX AND AROUND AGGREGATE; MAGNIFICATION, ABOUT 60 DIAMETERS

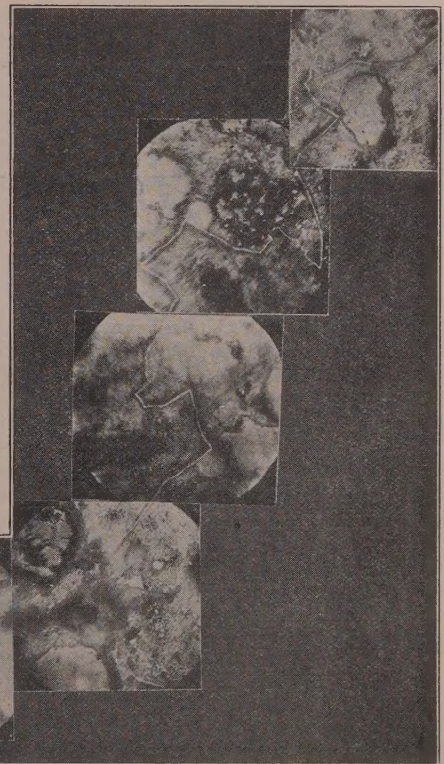
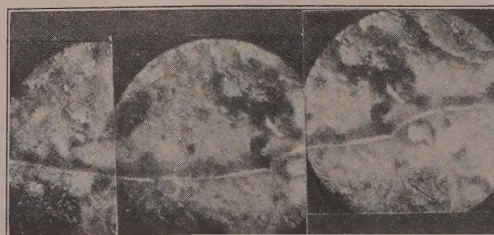


FIG. 13—DISRUPTIVE CRYSTALLINE DIKE; SPILLWAY OF DAM, ITHACA, N. Y.
Magnification, about 80 diameters

whether resulting from the hydration of cement or from other causes, have their origin in a minute pore, or fissure.

6. That other disintegrating actions are produced by water entering through pores into the mass, by reason of this water, whether fresh or loaded with chemically-active salts, dissolving portions of the cement matrix.

7. That when such entering waters are sufficiently saturated with soluble compounds, deposition in crystalline form takes place, with tremendous disruptive forces exerted on the surrounding material, i.e., the cement matrix.

8. That these disruptive forces pressing on the walls of the confining pore produce one or more fissures in the matrix, and that these fissures, in turn, act as capillary passages, with repetition of seepage, crystallization and wedging, the crystalline water filling in as the passages lengthen and widen, until a group of hard, disruptive progressing dikes effect actual disruption.

9. That this action is not confined to concretes exposed to sea-water, but affect other concretes, such as fresh-water dams, filter beds, buttress walls, sidewalks, etc., where defective materials or construction permit the entrance of water into the mass.

10. That the responsibility for concrete failures of many kinds need not necessarily rest solely upon the cement, but that other factors, such as proper choice of aggregates, efficient mixing, proper consistency and care in placing must be held equally responsible, since through these latter come the inducing causes of failure.

The next article in this series will be published in the issue of Feb. 13.

Ornamental Arch Effect Secured by Cantilever Design

Grade and Clearance Restrictions Together with Peculiar Local Conditions Result in Unusual Type of Concrete Bridge

MADE to appear like a simple ribbed-arch structure, the reinforced-concrete bridge, crossing the Chester River at Fifth Street, Chester, Pa., is in reality composed of two balanced cantilevers and an intermediate connecting span. The bridge is described in a paper presented before the American Association for the Advancement of Science, Dec. 30, 1914, by Henry H. Quimby, chief engineer of the department of city transit, Philadelphia, Pa. The main span is 95 ft. center to center of piers, and the shore spans, or counterweights, are 31 and 34 ft. long respectively. The bridge is 60 ft. in width, having a roadway 36 ft. wide between curbs.

The design provides for a uniform live load of 100 lb. per square foot and a double track street railway loaded with continuous trains of 50-ton cars. Concrete arches 6½ in. thick at the crown, turned between eight longitudinal ribs, support the roadway. Reinforced-concrete slabs on either side serve the double purpose of taking up the thrust from the roadway arches and

of supporting the sidewalk. The steel reinforcement of the ribs is composed of rods and riveted trusses, the latter being used to carry the forms and green concrete. No falsework was used. The east pier rests on wooden piles driven through soft mud to rock. Because of lack of friction and lateral support, only 16 tons were allowed on each pile. On the west shore, the pier rested directly on rock near the surface.

There were several reasons for adopting this peculiar design. An open-deck bridge

was specified, while at the same time an ornamental structure was desired, such as could be secured in concrete. If a concrete arch of usual design had been employed falsework would have been necessary. This would have impeded traffic, and owing to the nature of the soil would have been very expensive. Another governing condition was the demand for maximum clearance at the middle of the channel without raising the street grade. The cost of the bridge was \$33,000, or only \$3.43 per square foot.

Half-Mile Concrete Viaduct Provides Double-Deck Trafficway in Kansas City

Monumental Structure, Costing About \$625,000, Forms Important Travel Link Between City Center and Railway Terminal District

By H. H. FOX

Chief Draftsman, Waddell & Harrington (Since Dissolved) Kansas City, Mo.

NEARLY half a mile long and with two decks to carry a heavy volume of traffic, the Twelfth Street viaduct, a \$625,000 concrete structure of column and girder design with a 134-ft. arch midway between its ends, links the railroad terminal, warehouse and factory district of Kansas City, Mo., with the city center, and provides a direct route over the tracks of the thirty-two railroads which use the new Union Station in the Kaw Valley. The upper deck of the viaduct carries a double-track electric railway line, a 30-ft. roadway and a 5-ft. sidewalk. The lower deck provides a 30-ft. trafficway for vehicles only. The cost of the viaduct was assumed jointly by the city and the street railway company, the latter contributing \$200,000. The structure was designed by the firm of Waddell & Harrington, consulting engineers, of Kansas City. The contractor was the C. F. Graff Construction Company, of Seattle, Wash. L. R. Ash was city engineer at the time the plans were prepared.

Layouts for a steel structure were not given much consideration, as the city desired to make the viaduct a monument as well as a utility. A concrete structure alone appealed to all who had a voice in the matter. Layouts were then prepared for a concrete viaduct of both arch and girder design, and of a combination of the two. The final choice rested with the girder design with an arch near the center. This gave a well balanced structure, and with its simple lines and massive proportions seemed best adapted to the location. It was, moreover, the most economical.

UPPER DECK

The upper deck extends from Liberty Street, on the west, to Washington Street, on the east. This deck, as seen from the cross-section, provides a 5-ft. sidewalk on the south side, a 30-ft. roadway at the center, and 21-ft. 6-in. space for street cars on the north. This arrangement was adopted inasmuch as most of the vehicular and pedestrian traffic would approach the viaduct at the west end from the south. Thus by placing the car tracks on the north side the necessity was removed for this traffic to

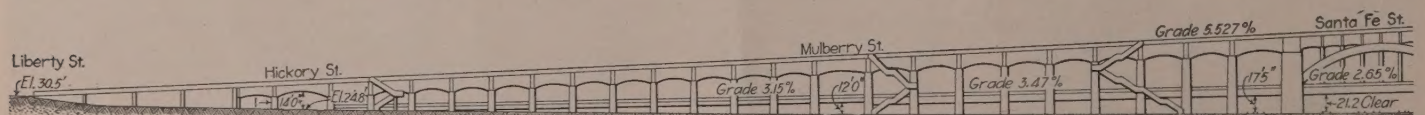
cross the tracks. The first layouts contemplated a 5.09-per cent grade, as this was the limit requested by the Team Owners' Association. However, on account of engineering difficulties, and to avoid heavy land damages, a 5.52 per cent grade was adopted.

To meet further demands of the Team Owners' Association, the lower deck was designed with a 3-per cent grade for vehicular traffic only. It extends from Hickory Street, on the west, to Beardsley Street, on the east, with the grades shown on the elevation. Originally the 3.15 per cent grade extended to pier 26 with the 2.34 per cent grade east from that point. After the construction of the lower deck had started, however, the railroads asked for more clearance than was provided at Santa Fé Street. To gain this extra clearance the lower deck was raised and made of less depth, with the resulting grades shown.

ROADWAY CONSTRUCTION

The roadways of both decks have a creosoted wood-block pavement 4 in. thick, placed on a waterproofing mat. This mat consists of one layer of 8 oz. open-mesh burlap laid on a heavy coating of waterproofing pitch applied to the concrete surface at a temperature of 470° F. This burlap is then swabbed with a similar coating of pitch and a layer of asphaltic felt, weighing 14 lb. to the 100 sq. ft., placed on top. Another swabbing of pitch is applied, and the surface well sanded. The wood blocks are then laid. On the lower deck the blocks are laid with close joints, but on the upper deck the blocks are laid with ⅜-in. openings between rows. A ⅜-in. by 2¾-in. opening is left between the blocks at the surface, and this is filled with hot gravel and pitch. Then the entire surface of the roadway is covered with a ½-in. thickness of stone shippings. This construction affords a good holding surface on steep grades.

The structure is designed for Waddell & Harrington's standard loadings. The floor systems are figured for class A on the roadways, class B on the sidewalk, and 50-ton cars on the tracks. The girders and arch ribs are figured for class B on the



ELEVATION OF HALF-MILE DOUBLE-DECK REINFORCED-CONCRETE VIADUCT CONNECTING THE TERMINAL,



LOOKING DOWN THE NEW TWELFTH STREET VIADUCT, KANSAS CITY, FROM ALONGSIDE ON BEARDSLEY STREET

roadways, class C on the sidewalk, and 40-ton cars on the tracks. Impact is added to the live load, using the formula $100/(L + 150)$ for highway loads, and $200/(L + 270)$ for electric railway loads. The unit stresses given in the table were used in the design.

The upper deck floor system consists of a reinforced-concrete slab, supported on the fascia, ballast, curb, and main girders longitudinally, and on the cantilever beams and cross-girders transversely. The longitudinal girders are spaced as shown in the cross-section, and the transverse girders are spaced from 7 ft. 3 in. to 8 ft. 3 in. centers, except in special cases.

SIDEWALK AND ROADWAY SLABS

The sidewalk slab is $4\frac{1}{2}$ in. thick, $\frac{3}{4}$ in. of this being for wearing surface. The reinforcement is run transversely only, except for spacing and temperature bars which run longitudinally, as the slab is not supported at the cantilever beams. The 8-in. roadway slab is divided into two sections by the curb, longitudinal, and ballast girders. The slab between the curb and main girders is reinforced in both directions, while the slab between the main and ballast girders is reinforced longitudinally only. The motorway slab which is 9 in. thick is also divided into two sections by the ballast, main and fascia girders. Both sections are reinforced in either direction. The roadway slab for lower deck is the same as the upper deck roadway slab between main and ballast girders. All slabs are figured continuous over supports and reinforced for both positive and negative moments. The fascia, ballast and curb girders are likewise made continuous over supports.

As is seen from the cross-section the columns and upper-deck longitudinal girders are spaced 18 ft. 6 in. from center line of

viaduct, making the cantilevers extend 11 ft. 6 in. from center line of girders. The regular intermediate cross girders are 1 ft. 4 in. wide and 6 ft. 5 in. deep from top of slab to underside of girder. At the columns the cross girders are 2 ft. 4 in. wide and 8 ft. 5 in. deep at center, the bottom being curved to a radius of 50 ft. At Hickory Street, special shallow cross girders are used to provide the necessary clearance. The cantilever beams in all cases are made of the same width as cross girders. The lower deck cross girders are spaced the same as for the upper deck. The regular intermediate cross girders are 1 ft. 4 in. wide and 3 ft. 3 in. deep. At the columns a cross girder 1 ft. 6 in. wide and 4 ft. 2 in. deep is used near each transverse face.

UPPER-DECK GIRDERS

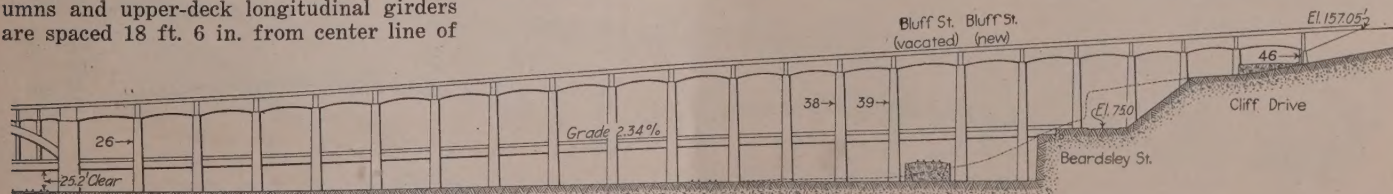
The upper-deck longitudinal girders are made continuous in groups of three and four spans, expansion joints occurring about every 130 to 200 ft. They are also made continuous with the columns. The spans vary in length from 33 ft. to 55 ft. 7 in. The girders have a uniform depth of 6 ft. 6 in. below slab at center and 9 ft. 6 in. at ends, except in first three spans where special girders are used. The railway girders vary in width 2 ft. 6 in. to 4 ft., whereas the highway girders vary from 1 ft. 6 in. to 2 ft. 6 in. The girders are figured as T-beams for positive moments, a constant I being assumed throughout, except for three spans mentioned. Proper consideration is given to the varying thicknesses in any one group. Wherever an expansion joint occurs the girders are made to slide on each side of the column. In this way but two columns at the most are affected by change in length of girders. The girders are made to

slide on planed steel plates. The base plates for the two girders at one column are riveted together with longitudinal angles. The sole plates on the girders have bars riveted to them, running back into the girders, so as to prevent any cracks in the bottom of the girders near the supports.

The longitudinal girders for the lower deck are on 36-ft. centers, the north girder being $9\frac{3}{4}$ in. and the south girder $21\frac{1}{4}$ in. off center line of columns. This is done in order to make the girders the same distance from inner face of columns. The girders are from 1 ft. 6 in. to 2 ft. wide and 8 ft. deep. The bottom of the girders is 4 ft. 6 in. below crown of roadway. The part above the roadway forms the lower deck railing. Expansion joints in the lower deck occur as a rule at every other column and the ends of the girders at expansion columns are made to slide on planed plates as in the upper deck. The expansion joints for the upper deck are located at different columns from those of the lower deck. The girders are figured as 0.9 fixed for positive moments, and fixed for negative moments.

MULBERRY STREET CROSSING

At Mulberry Street a special shallow construction was necessary in the lower deck to obtain the headroom of 14 ft. required. Shallow built-up cross girders, conforming to the crown of roadway, were used with one line of steel stringers at center. These cross girders are riveted to hangers which are imbedded in the longitudinal concrete girders. The tops of these hangers are connected by a built-up steel flange running the length of the girders and used as compressive reinforcement. All the steel beams are incased in concrete. The distance from top of roadway to bottom of girders is 2 ft.



WAREHOUSE AND FACTORY DISTRICT IN THE FLATS WITH THE UPPER LEVEL OF KANSAS CITY, MISSOURI



MIDDLE BAY OF DU BOIS ROUNDHOUSE—CRANE RUNNING RAIL ON LEFT

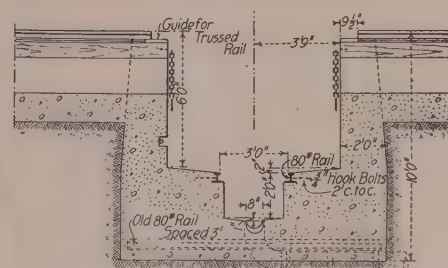
Reinforced-Concrete Roundhouse at Du Bois

Structural and Mechanical Features of Sixteen-Stall House Recently Completed by Buffalo, Rochester & Pittsburgh Railway

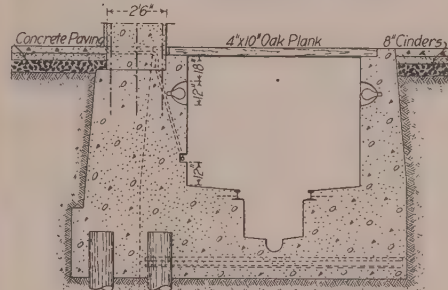
A REINFORCED-CONCRETE engine house with exterior walls of brick was completed and put into service last March at Du Bois, Pa., by the Buffalo, Rochester & Pittsburgh Railway. It is opposite an older and smaller sixteen-stall brick house served by the same turntable, the two houses completing the circle except for four entrance and outlet tracks. Features of the newer house are the reinforced-concrete construc-

tion, the traveling crane and the provisions for drainage.

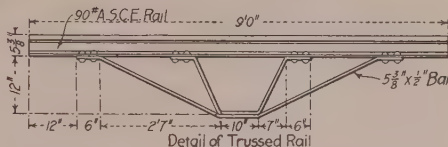
The stalls are 105 ft. long, out to out, the radius of the outer circle being about 195½ ft. The angle between stalls is 9 deg. 31 min. 37.33 sec., the chords on the inner and outer walls being respectively 15 ft. and 32½ ft. As the drawings show, two circular rows of interior columns divide the house into bays of 35, 42 and 28 ft. from



Section of Drop Pit on Center Line of Track



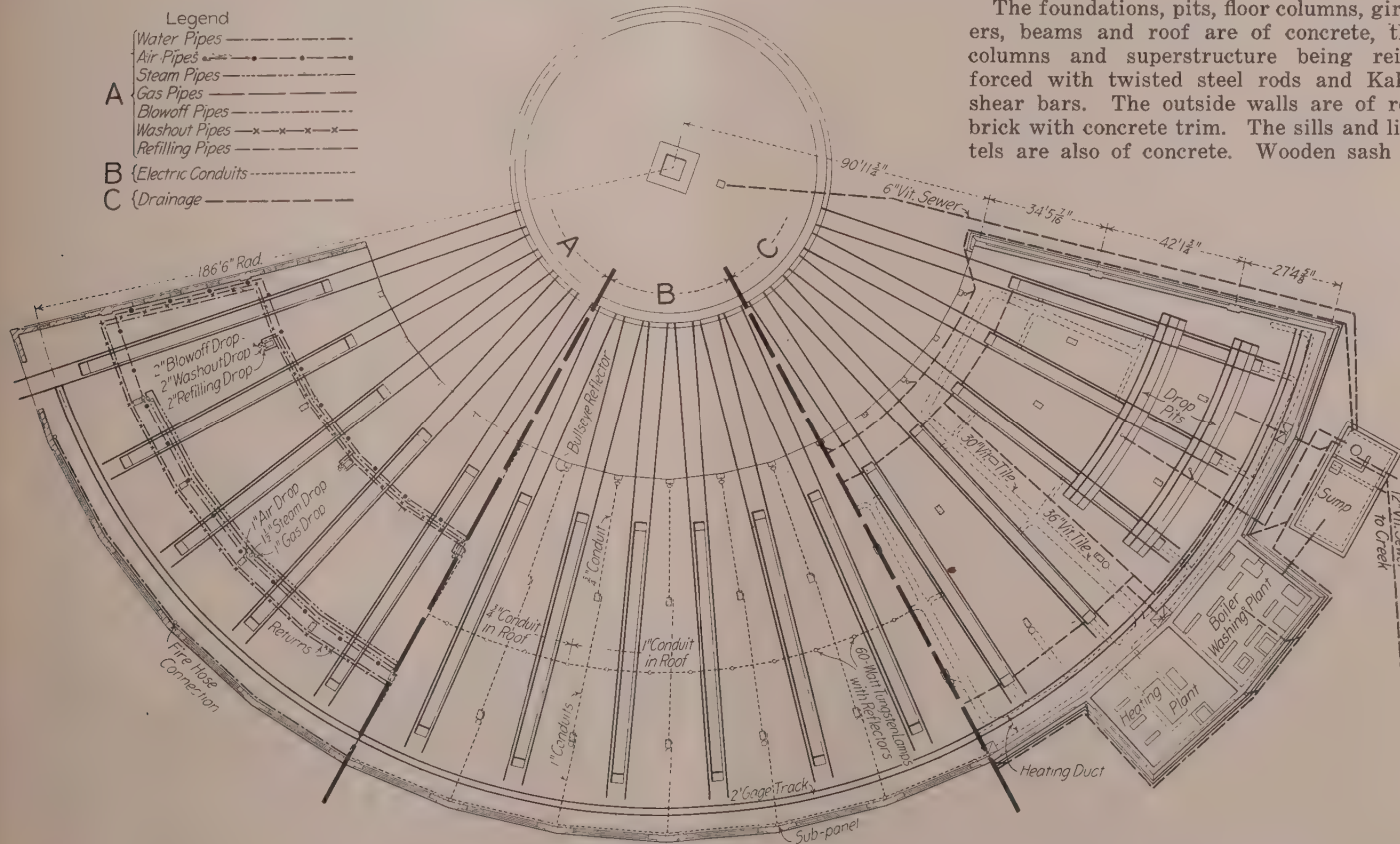
Section on Center Line of Columns



DETAILS OF DROP PIT AND TRUSSED RAIL

the turntable out. The drawings also show that the central bay rises 11 ft. higher than the remainder of the building, providing additional windows and housing for the electric traveling crane. Each track has a longitudinal pit 76 ft. long. The three most easterly stalls have a double transverse drop pit. The pits, as well as the roof, drain into a sump, whence the water is removed by an automatic electric centrifugal pump.

The foundations, pits, floor columns, girders, beams and roof are of concrete, the columns and superstructure being reinforced with twisted steel rods and Kahn shear bars. The outside walls are of red brick with concrete trim. The sills and lintels are also of concrete. Wooden sash is



THREE-PART PLAN OF HOUSE—SERVICE PIPES SHOWN IN SECTION A, LIGHTING IN B, DRAINAGE AND HEATING DUCTS IN C

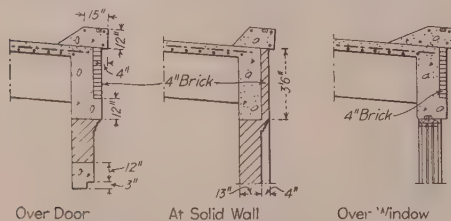
used for the windows. The outer panels opposite the ends of the tracks are built in units independent of the pilasters, so that in case locomotives overrun the ends of the tracks and crash through the wall the damage will not extend to the column and girder system. The entire building is carried on piles driven to refusal, there being two rows of piles spaced continuously about 3 ft. apart under the walls, and six piles under each interior column. Old rails reinforce the foundation walls and pit concrete. Allowable unit stresses of 16,000 lb. per square inch for steel in tension and 500 lb. per square inch for concrete in compression were used.

Some of the reinforced-concrete details are shown. The main columns, up to the crane rails, are 22 x 30 in., the long way with the tracks. Each column is reinforced with eight 1-in. twisted bars hooped with No. 0 wire 12 in. apart for the first fifteen feet and then 6 in. apart. Extra reinforcement is provided to take care of the flare just under the crane rail. Above this point there are columns 18 in. square over the larger columns and also at the midpoints of the connecting girders.

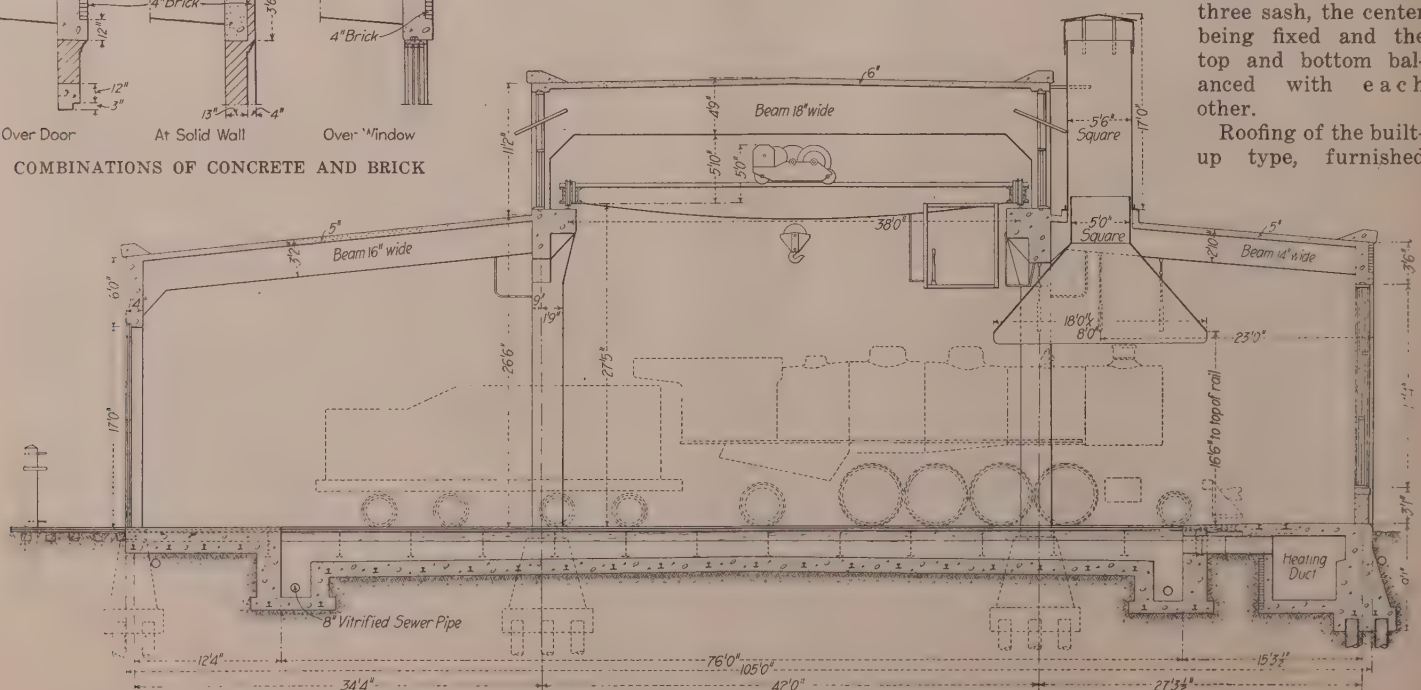
L-SHAPED GIRDERS

The framing plan shows the arrangement of beams and girders, the girders forming concentric rings and the beams connecting the rings. It will be seen that in the outer bay there are two intermediate beams in each panel, with room between the two for the smoke jacks, and that in the other bays there is one intermediate beam for each panel, except over the three stalls at the east end. Here, on account of the drop pits, it was necessary to accommodate engines headed in either direction. This necessitated smoke jacks at each end, and place is made for the three extra ones by the same arrangement of beams as in the outer bay.

The girders connecting the interior columns are of a very special nature. Details are shown of one of them. They are shaped



COMBINATIONS OF CONCRETE AND BRICK



LONGITUDINAL SECTION OF STALL, WITH RELATIVE POSITION OF LOCOMOTIVE, PIT, CRANE AND SMOKE JACK INDICATED

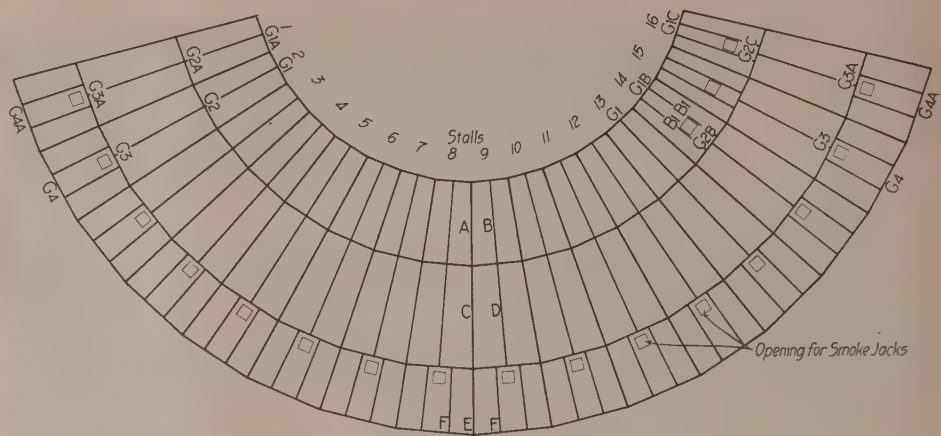
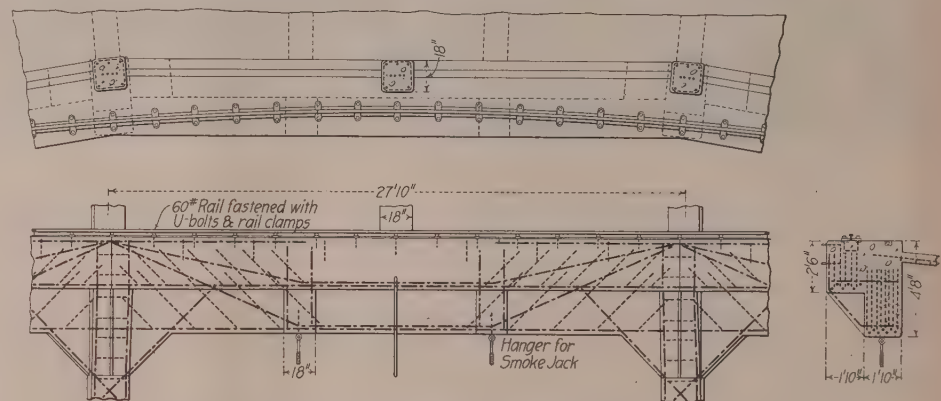


DIAGRAM SHOWING ARRANGEMENT OF ROOF GIRDERS AND BEAMS



L-SHAPED GIRDER G-3, CARRYING CURVED CRANE RUNNING RAIL

like an inverted L, the deeper portion carrying the upper columns and windows and hangers for the smoke jacks, the wing section carrying the crane rail. The curved rails are held in place by clamps engaging U-bolts set in the concrete in the proper position. The portion of the girder carrying the crane rail is strengthened by counter-ports to the main section of the girder.

The crane has a capacity of 15 tons and is used for lifting cabs and other parts of engines. To make it follow the curved track

properly the truck wheels are located on radial lines and connected by a geared driving shaft. The crane was furnished by the Shaw Electric Crane Company. It runs on 60-lb. rails.

Wood construction is used for the windows and doors, the lower sash of the windows being of the balanced type. The double engine doors give an opening 13½ ft. wide and 17 ft. high. The windows at the rear of the house are 21½ ft. long and 17 ft. high, divided vertically into five sets and horizontally into three sash, the center being fixed and the top and bottom balanced with each other.

Roofing of the built-up type, furnished

and applied by the H. W. Johns-Manville Company, is carried on concrete slabs 5 and 6 in. thick, depending upon the span. The same company furnished the smoke jacks, which are of asbestos wood.

PITS

As previously stated, the engine pits are 76 ft. long. They are 4 ft. wide, and are 2 ft. 6 in. deep below top of rail on the center lines at midpoints, dropping 6 in. at each end, and in addition the bottoms have 3-in. crowns for drainage purposes. The walls of the pits are 2 ft. thick. The bases have a minimum thickness of 12 in.; they spread to a width of 9 ft. and are reinforced transversely with old 80-lb. rails 4 ft. apart. At each end of each pit is a sump 6 ft. deep below top of rail; these sumps drain into the main sump already mentioned, the location of which is shown in the plan.

Half sections are shown on page 167 of one of the drop pits on center line of track and at a column. The pit drains both ways from the ends to a pipe alongside the middle track. Each drop pit is lighted with sixteen 60-watt Tungsten lamps with wire guards, set in recesses as shown. A detail is shown of the trussed rails by means of which the engine tracks are carried across.

Heat is supplied by a fan system installed by the Buffalo Forge Company, of Buffalo. The fan is located in a small addition back of stall 13, the air being forced through an underground circumferential duct from which laterals lead to the various pits. Most of the main duct is of concrete, varying in size from $5\frac{1}{2}$ ft. square at the heating plant down to about 3 ft. square near the ends. The ends, as well as the laterals to the pits, are vitrified tile from 36 down to 18 in. in diameter.

Alongside the heating plant is another small annex for the boiler washout system, which has a capacity of six engines per twenty-four hours, and was furnished and installed by the Cowles-MacDowell Engineering Company, of Chicago.

LIGHTING

Lighting is accomplished by bulls-eye reflectors placed at the end of each stall, one on each door post and two on each brick pilaster at the back of the stall, so located as to avoid shadows. General illumination is furnished by clusters in the upper roof. Plugs are also provided in each column for the use of portable extension lamps. All conduits and boxes are built in the concrete. All electrical work was placed by the Wheeler-Green Electric Company of Rochester, N. Y.

Hot and cold water and air and gas-line connections are supplied for each stall and were put in by the Osborn Machine Company, of Du Bois. These connections, together with those for the boiler washout system, are shown in the left-hand third of the floor plan. The lighting system is shown in the middle section, and in the right-hand third are shown the heating ducts and the drainage system.

As previously stated, the house was completed and put into service last March. At the time of completion the additional steam units in the power house had not been installed. A locomotive was therefore placed in stall 13 and temporary connections were made to the permanent system to permit the supplying of steam for the various services in the building.

Except for the special contracts men-

tioned, the entire building was constructed by the railway company forces. The plans were prepared by the engineering department, of which E. F. Robinson is chief engineer and W. F. Pond, office engineer, the general design being worked out in conjunction with the mechanical department, of which F. J. Harrison is superintendent of motive power and W. J. Knox, mechanical engineer. The field work was under the direct supervision of G. H. Stewart, master mason.

An Hour With a City Manager

All Sorts of Problems, from Police Controversies to Paving Specifications, Constitute the Day's Work in Springfield, Ohio

SEATED at the elbow of Charles E. Ashburner, city manager of Springfield, Ohio, a representative of the Engineering Record recently had an opportunity of observing what a variety of problems present themselves for solution in the brief space of an hour. An engineer who has handled a camp of several thousand men engaged in constructing a hydroelectric development back in the high Sierras of California, for instance, and has had to know how to buy good cook stoves, as well as hire cooks, separate tunnel miners and top workmen into different camps to prevent personal altercations, run a hospital for bodily ills, and a moving picture show for mental divertisement, operate half a hundred miles of railroad, all in addition to caring for the engineering and contracting details of getting concrete into dams, logs into lumber for forms and materials on hand on time—such a man can realize the multiplicity of things that come to a city manager's desk. For everything, routine as well as extraordinary matters, must come to the manager for disposal or transmission to the proper department.

VARIETY OF PROBLEMS

First was a police controversy. Then came a complaint about an alleged grafting garbage collector. A contract for a land right of way was signed and adjusted with the city attorney. Tentative pest-house plans were brought in by the health officer and a little engineering was done on the spot as to arrangement; slide rule calculations were made of costs. The manager had just come in from condemning a whole day's work of street paving along a car track because specifications were not lived up to. By night the paving had been relaid properly and that contractor will no doubt follow specifications. A long distance call to a brother manager cleared up a difficult point in paving specifications and the next morning's mail contained all the information available in the neighboring city. A sharp letter was dictated to a departmental superintendent asking for a reorganization of his entire force and so, said Mr. Ashburner, it goes on all day long. During all this period, assistants, heads of departments and other officials were coming and going without any formality, but no one stayed long and business was the only topic of conversation. For ordinary matters, informal verbal or written requests are made, but when an emergency exists orders are issued and must be complied with immediately or removals take place.

As an instance of cooperation between departments all police-stations have a stock

of red lanterns. Should a service main break, a motor policeman is dispatched at once and stays on the job until the department or service company gets there. Police post board of health notices. Economies of time and money are practised wherever possible. In street sweeping alone \$30 per day has been saved. A combined motor-driven sweeper, sprinkler, and pick-up machine covers 144,000 sq. yd. per day. A new hand plow has been rigged to throw material away from the gutter into the path of the machine.

As to the success of the plan from the outside and engineers' standpoint there appears to be no question. The city is getting efficiency and the politically inclined citizens and under-officials of the slow-moving type see that more and more of the pennies in the dollar are going for value received. They realize it is a good thing, but the idea creates strong opposition of the aggressive kind.

Indiana's Flood Problems Outlined by Professor Hatt

SIX main problems in the work of the Indiana Flood Commission were outlined in a recent paper presented by Prof. W. K. Hatt before the Indiana Engineering Society. Their solution is considered necessary before Indiana communities can protect themselves against floods.

There must first be proper information as to the amount of water to be carried safely in a channel. To determine this amount it is necessary to know the rainfall that may reasonably be expected at a time not too remote, and the rapidity with which this rainfall runs down the watershed.

The second problem is to design flood protection works to take care of the water which is to be carried. These involve cleaning and straightening the river beds and lengthening the bridges, removing obstructions, and building levees to retain the flood heights. If proper surveys exist reservoir control may be studied. The Indiana Flood Commission has gathered together a number of plans that have been drawn for the Indiana cities, and it is in a position to assist communities that desire advice on the nature of flood protection works.

Third, there must be some organization to finance and build flood protection works. This is a crucial problem. It involves the co-ordination of several at present unrelated agencies, as, for instance, the city government, the county commissioners and the railways. Of what benefit is it to a city like Peru to spend \$350,000 on a levee, if this scheme demands for its proper action the lengthening of a county or railway bridge, when the county commissioners or the railway officials, or both, refuse to co-operate?

Fourth, flood protection must be studied from the standpoint of a watershed as a whole. One city has made flood protection plans which deflect the water around the city, and throw it around in increased volume on its neighbor downstream.

Maintenance is the fifth problem.

The last problem is to delimit and properly apportion the action and responsibility as between the States and the Federal Government. At present the Federal Government controls all openings and obstructions in navigable streams. The logic of the situation would extend this to the upper reaches, because what happens there will affect navigation below.

Economic Design of Concrete Slabs

Analysis of Stresses and Costs of Reinforced Concrete Floor
Panel Construction, Based upon the Cheapest Possible Design

By J. NORMAN JENSEN

Architectural Engineer, Department of Buildings, Chicago

WHAT are the most economical unit stresses in both concrete and steel in the design of any reinforced concrete floor slab? This is the question that arises in the mind of the engineer who wishes to design so that the money expended is wisely spent. In various treatises on reinforced concrete there are elaborate equations and curves showing, for instance, that low unit stresses represent maximum economy in slab design. The structural designer knows the effect of low unit stresses in any design. He knows how these low unit stresses will thicken up his slab, increase the dead load on his beams and girders, make the columns already too large on the lower floors, larger than ever, and finally run up the cost of his footings. He is inclined to doubt the statements given in these treatises.

Upon the experienced designer one fact is forcibly impressed, and that is that the dead load represents too large a proportion of the total load in the average reinforced concrete design. How can he reduce this dead load? There are two ways open. One is the use of a larger percentage of steel, and the other is the use of a rich mix in the slab. Both ways ensure a thinner slab, and therefore a smaller dead load. It is the intention of this article to discuss whether these methods are economical or not.

The writer does not believe in applying the methods of the differential calculus in arriving at conclusions as to what constitutes maximum economy in the subject under consideration. He believes that when the owner's money is involved it is not wise to lean too heavily on a differential equation. To him the rational method is to make a great many designs and compare them.

DESIGNING DATA

In making comparative designs it is advisable to use stresses that are sanctioned by good authority. In the Middle West the Chicago Building Ordinance is generally accepted as the standard. This ordinance provides that in the design of slabs and beams: (a) The common theory of flexure should apply; (b) the steel should take all the direct tensile stresses; and (c) the stress-strain curve of concrete in compression is a straight line.

Although the most common mix for slabs is 1:2:4, provision is made in the ordinance for richer mixes. The allowable unit stresses and the ratio of the moduli of elasticity of steel to the various mixes are as follows:

Mix	Unit stress lb. per sq. in.	Ratio of the moduli of elasticity
1:2:4	700	15
1:1½:3	840	12
1:1:2	1015	10

The allowable unit stress for high elastic-limit steel is 18,000 lb. per square inch. In the design of these slabs the notation and formulæ found in standard text books on reinforced concrete have been used.

f_c = allowable unit stress in concrete; f_s ,

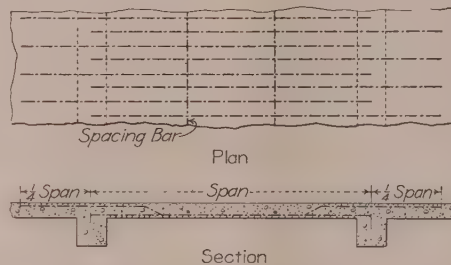
allowable unit stress in steel; n , ratio of the moduli of elasticity of concrete to steel; M , bending or resisting moment; A , steel area per foot of width of slab; b , width of slab (12 in.); d , depth of slab to center of steel; h , total thickness of slab; K , constant = coefficient of strength, and $p = A/bd$.

$$K = f_c^2 n (3 f_s + 2 n f_c) \div 6 (f_c + n f_c)^2$$

$$p = 1 / [2 (f_s / f_c) (f_s / n f_c + 1)]$$

$$d = \sqrt{M / K b}$$

Values for p and K for different values of n , f_c and f_s are given in Table 1. These working stresses are arranged in ascending order of K . For any one mix the values of p are also arranged in the same order.



TYPICAL ARRANGEMENT OF SLAB BARS

More values are given for the 1:2:4 mix than for any others, as it is the almost universal mix for building construction. The letters used in the first column in Table 1 are given as a convenient way of designating the unit stresses for the given mix.

In making an analysis of costs, slabs reinforced in one direction were designed for superimposed loads of 50, 75, 125 and 225 lb. per square foot for spans varying by 2 ft. from 8 to 16 ft., inclusive. Slabs reinforced in two directions were designed for superimposed loads of 75, 125 and 225 lb. per square foot for spans varying from 14 to 22 ft., inclusive. In both cases for the same span and the same load different mixes and percentages of steel were used. Each span and each load were analyzed using each of the combinations of stresses given in Table 1.

By superimposed load is meant the live

TABLE 1—COMBINATION STRESSES						
No.	Mix	n	f_c	f_s	p	K
A1.....	1:2:4	15	600	18000	0.0056	89
A2.....	1:2:4	15	650	18000	0.0064	101
A3.....	1:2:4	15	700	18000	0.0072	113
A4.....	1:2:4	15	700	16000	0.0087	120
A5.....	1:2:4	15	700	14000	0.0107	129
B1.....	1:1½:3	12	840	18000	0.0084	133
B2.....	1:1½:3	12	840	16000	0.0101	142
B3.....	1:1½:3	12	840	14000	0.0126	152
C1.....	1:1:2	10	1015	18000	0.0102	161
C2.....	1:1:2	10	1015	16000	0.0124	171
C3.....	1:1:2	10	1015	14000	0.0152	184

load plus the weight of the flooring, etc., on top of the concrete slab. Thus a superimposed load of 75 lb. per square foot is a live load of 50 lb. required by the ordinance for office buildings plus the weight of a wooden floor laid on sleepers embedded in cinder concrete.

A plan and section showing the typical arrangement of slab bars is given in the illustration. It will be noticed that each bar extends from the middle of the beam to the one-quarter point of the adjoining span. In this way the same steel is provided over the support as in the middle of the span. This was done as the slab under consideration is supposed to be a typical interior slab in which a bending moment of 1/12 over the support and the middle of the span is required by the ordinance. In slabs reinforced in two directions, the same general arrangement of steel is used, and the same bending moment employed, but only one-half of the total load taken in each direction. The span is taken center to center of supports.

METHOD OF COST ANALYSIS

In the small space allotted for the discussion of the subject of this article, it is impossible to reprint all the tables, etc., upon which the final conclusions were based. Table 2 gives the results of slabs designed for a superimposed load of 125 lb., using a 1:1½:3 mix for the spans given. The letter used on the left side of the table refers to the same letter given in designating the constants in Table 1. The other nomenclature used has already been defined. In designing any particular slab, a total thickness h was assumed, and the dead load of such a thickness was added to the superimposed load in obtaining the bending moment M . The depth of slab to center of steel d was then calculated using the K obtained from Table 1. If on adding ¾ in. to the lighter slabs and 1 in. to the heavier ones to the theoretical depth found, the total thickness h was the same as the assumed thickness, the bending moment values were accepted, otherwise the computations were gone over again until the as-

TABLE 2—DIMENSIONS AND COSTS OF SLABS DESIGNED FOR A SUPERIMPOSED LOAD OF 125 LB. PER SQUARE FOOT AND MADE OF 1:1½:3 CONCRETE

	Span	One-way Slab			Two-way Slab			feet
		12	14	16	16	18	20	
B1	M	2260	3220	4400	2010	2620	3330	ft.-lb.
	d	4.12	4.91	5.75	3.88	4.44	5.00	in.
	h	5	5½	6½	5	5½	6	in.
	A	0.41	0.49	0.58	0.39	0.45	0.51	sq. in.
	Steel.....	1.74	2.08	2.47	3.31	3.82	4.33	lb.
	Concrete.....	0.42	0.48	0.54	0.42	0.46	0.50	cu. ft.
	Total cost.....	14.8	17.2	20.8	19.5	22.0	24.5	cents
B2	M	2220	3170	4320	1970	2580	3280	ft.-lb.
	d	3.94	4.72	5.52	3.73	4.26	4.80	in.
	h	4½	5½	6½	4½	5½	6½	in.
	A	0.48	0.57	0.67	0.45	0.52	0.58	sq. in.
	Steel.....	2.04	2.42	2.85	3.82	4.41	4.92	lb.
	Concrete.....	0.40	0.46	0.52	0.40	0.44	0.48	cu. ft.
	Total cost.....	15.2	17.8	21.6	20.6	23.2	25.8	cents
B3	M	2170	3120	4320	1970	2580	3280	ft.-lb.
	d	3.78	4.52	5.32	3.60	4.11	4.64	in.
	h	4½	5½	6½	4½	5½	6½	in.
	A	0.57	0.68	0.81	0.54	0.62	0.70	sq. in.
	Steel.....	2.42	2.89	3.44	4.59	5.26	5.95	lb.
	Concrete.....	0.38	0.44	0.52	0.40	0.44	0.48	cu. ft.
	Total cost.....	15.9	18.7	22.3	22.9	25.8	28.9	cents

sumed and final thicknesses of slab agreed. These thicknesses of slab were given to the nearest $\frac{1}{4}$ in. While this may seem to be needless refinement, it was necessary to work that close in order to arrive at correct conclusions.

Knowing d the steel area per foot of width of slab A was obtained using the corresponding p in Table 1. The weight of steel per square foot was obtained by multiplying A by 3.4, and then taking 25 per cent additional due to negative bending moment (see illustration). Shrinkage steel or spacing bars were not included in these weights. The concrete quantities are given in cubic feet, and the total cost in cents per square foot.

In looking over this table it will be seen that the bending moment varies for the same span. This is because in the slab the dead load is such a large proportion of the total load that any slight decrease in the total thickness will materially affect the bending moment.

UNIT COSTS

In the above table the cost of steel in place has been estimated at 3 cents per pound. The cost of concrete per cubic foot has been taken as follows:

	Mix	Cost per cubic foot, cents
A.....	1:2:4	21
B.....	1:1½:3	23
C.....	1:1:2	26

It is believed that these costs are representative of the unit costs on any large job in the Middle West. It is realized that it is not wise to rely wholly on these unit costs, and cost analyses have also been made on the basis of steel at 2¾ cents per pound, and concrete 2 cents higher per cubic foot than given above. In no case has the cost of the form work been included in the total cost, as it would be practically the same for all slabs.

The total costs for each span and superimposed load were tabulated. These costs were based on the values given above. Using the same quantities of steel and concrete, new costs were figured on the basis of unit costs of concrete as given above, and steel at 2¾ and 3 cents per pound, and also unit costs 2 cents higher than those given above. In this way four different combinations of unit costs were obtained. It is thought that these four combinations will cover the ordinary variations in unit costs.

On comparing the four different combinations of unit costs it was discovered that the same combinations of unit stresses for any particular load and span always gave the same relative result. If certain stresses were most economical for any one of the four combinations, they were also most economical for all of them.

In arriving at a decision as to the economy of different designs it was necessary to make allowance for the decrease in thickness for the richer mixes and the higher percentages of steel. An inspection of Table 2 brings out the fact that higher percentages of steel means a thinner slab. A thinner slab would, of course, mean less dead load on the beams, girders and columns and this would mean that less steel and concrete would be required in the panel to carry the superimposed load. It is hard to give an exact figure as to how much a saving in cost would be represented by a less dead load, but an estimate of a typical panel seemed to indicate that the de-

crease of 1 in. in the thickness of the slab would mean the decrease of 1 cent per square foot in the cost of the panel.

CONCLUSIONS

On the above basis designs were compared. For any one mix the most economical design for any span and any load was that in which the maximum unit stresses in both the concrete and the steel were used. That is to say, the unit stresses of 700 and 18,000 (A3) were the most economical for the 1:2:4 mix, 840 and 18,000 (B1) for the 1:1½:3 mix, and 1015 and 18,000 (C1) for the 1:1:2 mix. The evidence that low unit stresses in either concrete or steel were uneconomical was quite conclusive. These facts were true in both the one-way and the two-way slabs.

Comparing the one-way and the two-way slabs for the same mix, span and load it was found that the two-way slabs were decidedly more economical as they were both lower in cost and the slabs were considerably thinner. The economy was more apparent than real as the cost of the additional beam required in a panel reinforced in two directions offsets the economy in the slab, and the panel taken as a whole instead of the slab only is more costly than the panel reinforced in one direction only.

The series was computed with especial reference to the economy of a rich mix in a slab, if such could be proven. There was not much variation in the cost of two slabs of the same span and load but of different mixes. Keeping in mind the assumption that a saving of 1 in. in the thickness of the slab would mean a saving of 1 cent per square foot in the cost of the slab, it was found, in general, that the 1:1½:3 mix was more economical than the 1:2:4 mix for the one-way slabs and that the 1:1:2 mix would not be considered economical at all. In the slabs reinforced in two directions, the 1:2:4 mix was found to be the most economical almost without exception.

To Compute Offsets to Circular Curves

Application of the Binomial Theorem Eliminates the Necessity for the Use of Logarithmic Versed Sines

By LEOPOLD PISTNER

Junior Engineer, New York Public Service Commission, First District

THE PROBLEM of finding the offset to a circular curve, given the abscissa, occurs very frequently in engineering work. In some cases the offsets at a large num-

ber of points on the same curve are required, and it is, therefore, desirable to have a method which is rapid, convenient and so simple as to make mistakes improbable.

In the figure shown the object is to find y with x and R given. A method which immediately presents itself is that of finding $\theta = \sin^{-1} x/R$ and then finding $y = R \text{ versin } \theta$. If a table of logarithmic versed sines is at hand this method is both rapid and accurate. The more extended tables of logarithms, such as those of Vega and Bruhns (and such tables are required, since θ is usually small) do not, however, contain logarithmic versed sines. The table of cosines must, therefore, be used, and y must be obtained as $R - R \cos \theta$. Where R is large the quantities R and $R \cos \theta$ are both large, and their difference, the quantity in which we are interested, cannot be very accurately determined by this method.

ELIMINATING TRIGONOMETRY

The following method, not involving the use of trigonometric functions, is well suited to curves of both the largest and the smallest radii. From the figure it is at once apparent that

$$y = R - \sqrt{R^2 - x^2}$$

This form is not convenient for logarithmic computation, but may be made so by expanding the second term by the binomial theorem. Performing this operation we have

$$y = R - \left(R - \frac{x^2}{2R} - \frac{x^4}{8R^3} - \frac{x^6}{16R^5} - \frac{5x^8}{128R^7} - \dots \right)$$

which may be arranged as

$$y = \left(\frac{x^2}{2R} \right) + \left(\frac{x^2}{2R} \right)^2 \frac{1}{2R} + \left(\frac{x^2}{2R} \right)^3 \frac{1}{2R^2} + \dots$$

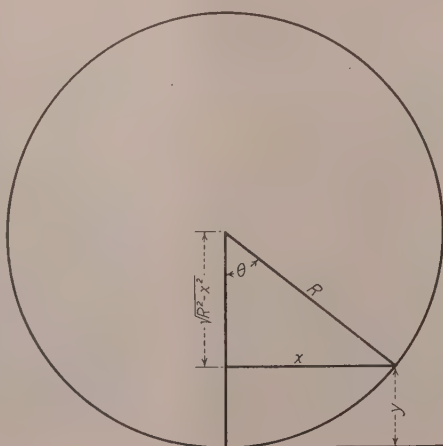
The convenience of this form is immediately apparent, the terms succeeding the first being simple functions of the first term. Three terms give results accurate to 1/1000 of a foot even for the most extreme of cases. The arrangement of the logarithmic work may be made very compact. Since the second and third terms are relatively small, they may even be very accurately computed on the slide rule, only the first term being found by logarithms.

EXAMPLE

An application of this method to a rather extreme case follows. The problem is to find the offset to a circular curve of 200-ft. radius when $x = 75.397$. The logarithmic work is as follows:

$$\begin{aligned} \log x &= 1.87735 \\ \log x^2 &= 3.75470 \\ \log 2R &= 2.60206 \\ \log x^2/2R &= 1.15264 = \text{antilog } 14.212 \\ \log (x^2/2R)^2 &= 2.30528 \\ \log 2R &= 2.60206 \\ \log (x^2/2R)^3 &= 3.45792 \\ \log 2R^2 &= 4.90309 \\ 8.55483 &= \text{antilog } 0.036 \\ 14.753 &= y \end{aligned}$$

It was of course unnecessary to compute the second and third terms by logarithms. Since neither has more than three significant figures they may both be obtained, accurate to thousandths, by the slide rule.





FINISHED CONCRETE UNITS ASSORTED AT THE KINGSLAND SHOPS

Five Bridges Erected in Two Days

Unit System of Reinforced Concrete Solves Time Element on Overhead Farm Crossings Rebuilt by Delaware, Lackawanna & Western Railroad

THE UNIT SYSTEM for reinforced-concrete construction has been used in building a number of overhead crossings on the old main line of the Delaware, Lackawanna & Western Railroad near Hackettstown, N. J. Five wooden truss bridges 12 ft. wide, used principally as farm crossings, had so deteriorated from engine gases that they had to be replaced. The abutments, which were substantially built of good, dry masonry, could be used again for the new structures. The selection of the type to be favored had to be made between steel, concrete built in place and concrete built in units, as a more permanent construction than wood was desired.

The first two types were found more expensive than the latter because of the location of the bridges. Hackettstown is located 57 mi. from Hoboken and the bridges are about 1½ or 2 mi. farther west. In transporting men back and forth between Hackettstown and the company's shops at Kingsland, a few miles west of Hoboken, a considerable number of working hours would be lost. Hence the method employing the use of reinforced concrete in units was adopted and the units were built at the Kingsland shops. In this way no working hours were lost, as the men could be taken off other work and put back on it immediately after finishing the units. Furthermore, all facilities for building forms and handling material were available. The units were built alongside the tracks in the yards, as the illustration above shows. All five bridges were erected in two days.

DESIGN

Four of the bridges are of the same type, while the span of the fifth necessitated a different design. Each of the four bridges consists of seven pieces, namely, two abutment blocks, two balustrade trusses and three floorbeams. The design of these units is shown in the drawings and all, except the balustrade trusses, are provided with hooks to facilitate handling. The abutment blocks were not designed to take any load except their own dead load when being handled. The vertical sides were reinforced so as to brace the ends of the trusses. Clearances

of about 4 in. were provided at the sides so that the units could be shifted if necessary to insure proper alignment. The balustrade trusses carry their dead load only, as they have not been connected by the bridge floor. They were designed so that they could be handled by slings introduced at the panel points indicated on the drawings. The length of these trusses varied from 35 ft. 8½ in. to 39 ft. 9 in. The casting of them, in spite of their different lengths, was accomplished by the same forms simply by using different spacing between the triangular forms for the panels. Consequently, the truss members are somewhat heavier for the longer spans than for the shorter.

The floorbeams are of T-section and were designed for a uniformly distributed load of 125 lb. per square foot, without impact, or a 10-ton traction engine with a 5-ft. spac-

ing between wheel centers and a 10-ft. wheel base. The load per wheel was assumed at 2.5 tons. Of these loadings the first gave the maximum moment for the beam, while the concentrated loads had to be used for the slabs. The slab was considered as an independent cantilever and the assumption was made in designing it that the concentrated load would act on a strip 2 ft. wide. The yardage and weights of these units are given in Table 1. Each bridge of the shorter span contains 6340 lb. of reinforcement and other steel, while each of those of the longer spans have 6865 and 7225 lb. respectively.

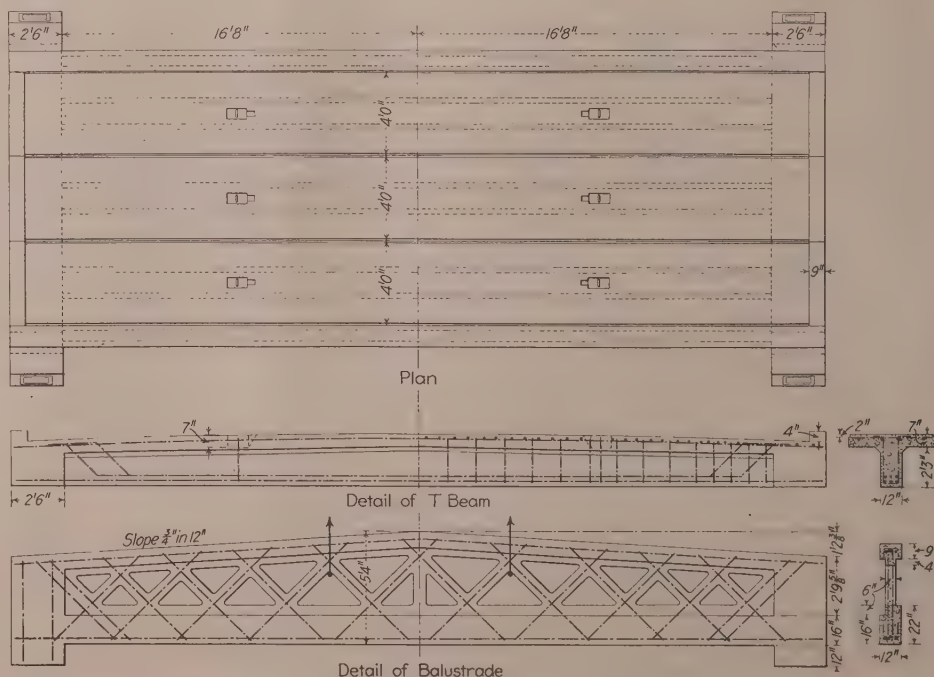
ERECTION

The units were loaded on flat and gondola cars, making one trainload for all five bridges. A locomotive crane was used for wrecking the old structures and erecting the new. As soon as the abutments had been stripped a thick coat of 1:3 cement mortar was spread on top of it and the abutment blocks were set and aligned. Then the floorbeams were placed and finally the balustrade trusses were erected. The spaces between the floorbeams, balustrade and abutment blocks were closed on the sides by boards, and a 1.3 cement grout was shoveled into the pockets. This grout was tamped by bars so that it filled the spaces completely. No grout was placed between floorbeams, but they were set on a thin layer of grout on the abutment blocks. At the junction between floorbeams, however, notches had been left, so that water-tightness could be obtained by calking with oakum and pitch.

The various steps of erection are shown on the opposite page. The operation required little time; at 9 a. m. work was begun demolishing the old structure and at noon one of the bridges was in place. Later on the floor was covered with a dirt fill for a wearing surface and the ends of the bridge were backfilled.

FIFTH BRIDGE

As mentioned previously one of the bridges had to be designed specially because of the length of span. This structure is located 1.85 mi. west of Hackettstown and



T-BEAMS AND BALUSTRADE TRUSSES FOR SINGLE-SPAN BRIDGES

TABLE 1—YARDAGE AND WEIGHTS OF UNITS OF ONE-SPAN BRIDGES

Member	Number	30 ft. 8½ in.		Free span— *33 ft. 4 in.		34 ft. 9 in.	
		Cu. yd.	Lb.	Cu. yd.	Lb.	Cu. yd.	Lb.
Abutment block	2	5.0	20,250	5.5	22,275	5.5	22,275
Balustrade truss	2	9.0	36,450	9.5	38,475	10.0	40,500
T-beam	3	17.5	70,875	21.0	85,050	23.0	93,150
Total for bridge	7	31.5	127,575	36.0	145,800	38.5	155,925

*Two bridges of this span.

spreading of the tracks had determined the spacing of the old abutments at 40 ft. at the ground level. Because of the inclined faces of these abutments the free span of the bridge was 42 ft. 3 in. Allowing 2 ft. at each end for bearing, the total length of the structure was 46 ft. 3 in.

On account of the depth of floor required for a single span the road could not be raised sufficiently to keep to the under clearance of the old bridge. It was, therefore, decided to introduce an intermediate pier and build the bridge in two spans of equal length. Because of the shortness of these spans the T-beam sections for the floor were abandoned in favor of six rectangular pieces, of which three constituted the width of the roadway. The center piece was made 4 ft. wide and 16 and 20 in. deep at abutment and pier respectively, while the two side pieces were made 5 ft. wide. The effective width of these latter was 4 ft., as the roadway was to be 12 ft. wide. The additional foot provides for the guard rail and the concrete work projects 1 ft. above the slab. This guard rail is provided with sockets, formed by pieces of 3-in. pipe 12 in. long spaced 6 ft. 5 in. on centers, for supporting the pipe railing.

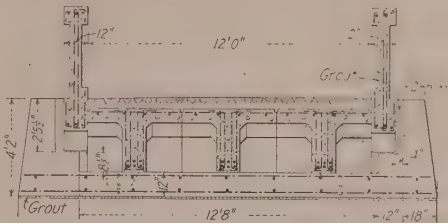
The abutment blocks are designed differently from those used for the other bridges as shown in the illustration. Their length is 14 ft., or the same as the overall width of the bridge. They are 3 ft. wide, of which

9 in. project 16 in. above the rest to form a vertical support for the ends of the slabs. A grouting space of about 3 in. was provided, so that the bearing surface is about 2 ft.

PIERS

A feature is the design of the pier. It consists of a U-shaped footing, which is buried in the ground, together with two columns and a cap. The footing is 3 ft. 6 in. wide, 13 ft. 10 in. long and 16 in. deep and was built in place while the other bridges were being erected. At each end it is provided with 3½ x 3½-ft. blocks, which project 3 ft. 2 in. above the beam, and on top of which the columns are set and grouted in pockets 6 in. deep. These pockets are 22 in. square, so as to provide a 1-in. clearance for grouting around the 20 x 20-in. columns. As the area of these blocks was sufficient to distribute the pressure on the soil at 3 tons per square foot, it was not found necessary to reinforce the beam between the blocks to distribute parts of the load. The beam consequently acts as a spacer and tie for footings.

The free length of the columns is 20 ft. and the overall length is 21 ft. As mentioned previously they are set 6 in. deep into the foundation blocks, and grouted. The connection between the columns and the cap had to be designed with the utmost care, as moments due to wind loads and lateral



SECTION OF SINGLE-SPAN BRIDGE

forces, such as impact against the guard rail, which can not very well be calculated, had to be provided for. For this purpose the sockets in the cap were made 16 in. square and 6¾ in. deep and the top of the column cap was reduced to 12 in. square for a depth of 6 in., thus providing a ¾-in. grouting space over the column top and a 2-in. space around it. Before setting the cap a ½-in. layer of grout was spread over the top of the column to fill the ¾-in. space and thus insure an even bearing of these members. In addition to the tie furnished by keying the column into the cap, two of the ¾-in. column bars projected into 3-in. holes through the cap. In forcing grout into these holes the 2-in. recess around the column top was filled, thus completing the bearing and the tie between the cap and the column.

The cap is 2 ft. 2 in. square and 15 ft. long and the floor slabs have 2-in. recesses holding the pier in a vertical position. No grouting was done between slabs or between slabs and pier. The yardage and weights of the units are given in Table 2. The weight of the reinforcement and other steel was 7675 lb., not including the railings.

As mentioned above, the bridge is provided with 2-in. pipe railings supported at distances of 6 ft. 5 in. These railings were assembled in the Kingsland shops, so that



OLD WOODEN BRIDGE TO BE REPLACED—TIME 9 A. M.



ABUTMENT BLOCKS IN PLACE—ERECTION OF T-BEAMS



ERECTING BALUSTRADE TRUSSES AFTER PLACING FLOOR



CONCRETE BRIDGE FULLY COMPLETED—TIME 12 NOON

TABLE 2—YARDAGE AND WEIGHTS OF UNITS OF TWO-SPAN BRIDGE

Member	Number	Yardage, cu. yd.	Weight, lb.
Abutment block	2	6	24,300
Slab	6	40	162,000
Column	2	4	16,200
Footings and cap	2	8	32,400
Total for bridge	12	58	234,900

two pieces, when jointed, formed the railing for one side. After being erected in place the railing was grouted to the guard rail.

The erection was similar to that of the other bridges and the joints between the slabs were calked. The wearing surface of the bridge was made of dirt.

The design and construction have been in charge of the engineering department of the

Lump-Sum Contracts Favored for Washington Roads

State Highway Commissioner, in Annual Report, Discusses Troubles with Unit Price System, Resulting in Unbalanced Bids on Local Work

UNREASONABLE and unbalanced bids, submitted under the unit-price type of contract, have been eliminated on State highway work in Washington, according to the recently published report of Commissioner William R. Roy for the year 1914, by the adoption of the lump sum plan. The

from careless preliminary estimates, and from unreasonable and unbalanced bids, the lump sum contract system was made obligatory in permanent highway work. After being in force for nearly two years the system, Commissioner Roy says, has had the effect of making contractors more careful in preparing bids. The county engineers of the State have certainly prepared closer and more complete estimates of cost.

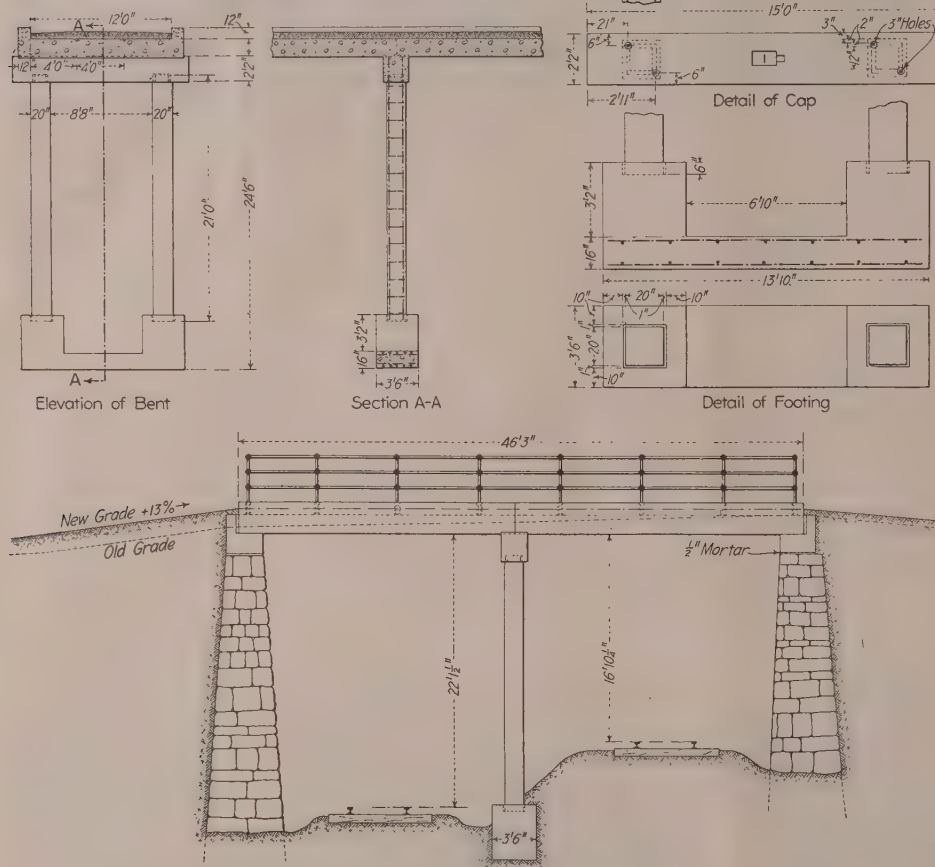
RESULTS COMPARED

For the purpose of comparing results obtained under the two systems of awarding contracts, there has been selected from the total list of permanent highway contracts completed all of those on which the work required to be performed was not increased or diminished during construction. There were 103 such contracts, and it happens that they were equally divided between the lump sum and unit price systems—52 unit price and 51 lump sum contracts. Of the unit price contracts, 24 went an average of 32.2 per cent in excess of the estimates. This average percentage of excess is reduced to 18.3, if four of these contracts, where the estimates were later proved to be utterly wild, are disregarded; on these four contracts, each in different counties, the increases are respectively 76 per cent, 95 per cent, 104 per cent and 132 per cent. Seven of the unit price contracts were completed at practically the estimated cost and 21 were completed below the estimate, the average saving being 8.2 per cent.

Fifty-one contracts have been let on the lump sum basis; five of these were completed at a cost in excess of the estimate, the average over-run being 20.2 per cent; these five contracts were in sections where there is very little competition for work. Four contracts were completed at approximately the estimated cost and 42 were below the estimate, the average saving being 11.0 per cent. It is seen from this that of the unit price contracts slightly over 51 per cent were completed at the engineers' estimate or below, while of the lump sum price contracts over 90 per cent were completed at the engineers' figures, or lower.

In commenting on this comparison, Commissioner Roy states that during the past 2 yr. contractors have been turning their attention to road work in increasing numbers. The result has been more competition and keener bidding for contracts. It is pointed out also that more contractors are "going broke," partly due to failure to appreciate the essential difference between highway construction and the classes of work to which they have been accustomed.

GROSS OPERATING REVENUES FOR NOVEMBER, 1914, on the large steam railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were \$1023 per mile, showing a decrease of \$157 or 13.3 per cent as compared with November, 1913. Operating expenses were \$732, a decrease of \$112 or 13.3 per cent. Net operating revenues, therefore, were \$292—a decrease of \$45 or 13.4 per cent, and operating income was \$242—a decrease of \$42 or 14.7 per cent. The operating ratio was 71.5 per cent, as compared with 71.3 per cent in November, 1913, and 66.4 per cent in November, 1912. Considering the three main districts, the respective ratios for November, 1914, and November, 1913, were as follows. Eastern district, 76.1 and 77.8; Southern, 74.5 and 70.4; Western, 65.9 and 65.3.



ELEVATION, SECTIONS AND DETAILS OF DOUBLE-SPAN UNIT-BUILT BRIDGE

Delaware, Lackawanna & Western Railroad, of which G. J. Ray is chief engineer and A. B. Cohen, concrete engineer. G. T. Hand, division engineer, supervised the building of the units at the Kingsland shops, and the erection of the bridges.

THE HYDRATION OF PORTLAND CEMENT is now under investigation at the Pittsburgh laboratory of the Bureau of Standards. According to the annual report of the director of the Bureau of Standards the first series of tests, already completed, shows what the products of hydration of the constituents of Portland cement are under normal conditions, and also which of the constituents produce the early and which the later hardening. These tests were made with materials produced in an electrical furnace, and with some commercial cements, but in no case were the actual products of hydration compared with the strengths produced. The tests now going on, however, include the investigation of physical properties.

lump sum contract provision has drawn much criticism from county engineers and contractors, and an explanation of the intent of this provision of the law is given in the report.

The law requires the engineer to prepare a preliminary estimate of cost, along with the plans and specifications for an improvement. Unless the estimate of cost is carefully prepared by an experienced engineer there is possibility that a county may be lead into undertaking an improvement the final cost of which may be far in excess of the expenditures originally planned. Several flagrant instances of this occurred on contracts entered into under the unit price system during the first two years the law was in force. A variation of 10 per cent between the preliminary estimate and the final cost may easily be expected, but a variation greater than that figure in ordinary road work is usually due either to carelessness in preparing the estimate, or the development of conditions during the progress of the work that could not well be foreseen. In the hope of protecting the counties

Design Low Dam for 30-Foot Height Increase

Structure Across Nolachuckey River Has Been Provided with Drains and Lead Seal so that Its Height May Be Doubled Without Unwatering

A DAM built across the Nolachuckey River, Tennessee, in such a way that it could be raised from 34½ to 65 ft., when the demand for power should require it, was described by W. V. N. Powelson, consulting engineer, New York City, in a paper entitled "Financial Safety in Water Power Development, Including a Description of the Nolachuckey Hydroelectric Plant of the Tennessee Eastern Electric Company," presented Dec. 31, 1914, in

it would have been wise to build initially a plant with a capacity of 16,000 maximum wheel horsepower.

PLAN OF DEVELOPMENT

An examination of the existing markets in the three towns to be served indicated that it would be unwise to make an initial development of the whole head available. The problem presented was to design a development the cost of which could be sup-

ported by the existing market, but so built that no substantial part of the initial development would be wasted in enlarging the plant, later on, to the ultimate capacity of the site. It was considered to be an advantage if the design could admit the increase by reasonable amounts as new markets developed.

The existing market indicated that the initial height of the dam should be about 34½ ft.; but in order that it might not be necessary later to uncover the river bottom with all the hazards incident to such work, it was thought wise to put in initially a base for a dam of the ultimate height and to carry it above water, and this was accordingly done.



THIS DAM CAN BE MADE 30 FEET HIGHER IF MORE POWER IS NEEDED

Note stepping of profile and cantilevered crest.

Philadelphia, before section D of the American Association for the Advancement of Science.

THE DAM SITE

The best site available was quite remarkable. The bottom of the river was solid ledge rock of dolomite, free from boulders and covered with sand of a maximum depth not exceeding 2 ft. It was a very easy matter to push a ¼-in. iron rod down through the sand and obtain the clear ring of the rock, which appeared practically level all across the river at a depth between 6 and 9 ft. below low water. The river was but 220 ft. wide, and the banks were of solid exposed rock, sloping at an angle of about 45 deg. to a height on one side of over 100 ft. and on the other side between 70 and 80 ft.

With a dam raising the water 70 ft. it was estimated that the storage available would produce a minimum flow of 600 sec.-ft. during the driest year likely to be encountered.

The character of the market indicated a weekly load factor of about 40 per cent, so that during the very driest year, it was estimated, there would be available at all times, without recourse to steam, 9000 hp. on a 40-per cent weekly load factor, and during the other years considerably more.

The characteristics of the stream and the steam power available in the existing public utility plants acquired were such that had the initial market been sufficient

As an added precaution some old steel cables that were available were laid in the concrete of the initial dam and brought to the surface in such a way that steel rods may be hooked into this cable and the new concrete cast around them. The initial development has been so executed that all the additional concrete required to increase the head to 70 ft. can be laid in the dry without the necessity of uncovering any portion of the river bottom. The construction plant has been retained at the site ready to do this on short notice.

SLUICeway

The specifications required that the dam should be provided with a sluiceway so as to make it possible to draw down the pond. This was accomplished by leaving a clear space or slot about 6 ft. wide between the dam proper and the headgate structure, from the top clear to the rock bottom of the river, except for a reinforced-concrete connection about 2 ft. thick and of ogee form. This connection serves as a seat for a regulating gate and to carry off its discharge when opened. The seat of this gate is 5 ft. below the top of the dam, and the purpose of the gate is to permit regulation of the flow so as to protect the 5-ft. pin type flashboards with which the dam is fitted. The gate is 6 ft. wide and if fully opened would, when the water is flush with the top of the flashboards, present a clear opening 10 ft. deep and 6 ft. wide. The balance of the 6-ft. slot below the seat of this gate was fitted with oak stop logs, 10 x 10 in. in section, going down to the bottom of the river. This slot was fitted with two grooves about 3 ft. apart for stop logs so as to admit of replacements of logs without drawing down the pond.

This form of sluice seemed to be the best suited to accomplish the purpose. It was very cheap to build; it had no part which was not readily accessible for replacement and repair; and it was perfectly reliable if, for any reason, it should be necessary to draw down the pond, because, with a suitable log pulling device, additional stop logs could be pulled out as the pond lowered, thus preventing pulling the logs out under a great head. Besides these advantages it was very useful for bypassing water during the construction of the dam, and gave an excellent account of itself during the final closure.

When the final closure was to be made the water was pouring through the slot about 14 ft. deep. With a frame sliding in the stop log groove there was no trouble in quickly sliding logs one after another into their proper place. Within 2 hrs. all the logs had been placed from the bottom of the river to the top of the dam. This type of construction was preferred over that in which the gate is operated at an opening near the base of the dam.

HEADGATE STRUCTURE

The headgate structure was so designed that, when the head is raised from 39½ ft. (with flashboards) to 70 ft. the same headgates, screens and hoists will be used, and

will be placed at a higher level, so as to operate with no greater head against the gates than in the initial development. The penstocks, when the head is raised, will be connected with new openings higher up. The penstocks for the two wheels initially installed and nearest the dam are 9 ft. in diameter, but the headgate structure has been designed for 12-ft. penstocks for the two wheels furthest from the dam and not initially installed. The wheels are all to be of the same size, but for the purpose of equal regulating qualities the wheels furthest from the dam required larger penstocks with reduced velocities.

The Nolachucky River is subject to very sudden and great floods, and although the river has a natural slope of about 6 ft. to the mile, it has been known to rise in flood at the site of the dam to 35 ft. above its low water mark, at which time the estimated discharge was around 50,000 sec. ft. This is very large from a drainage basin of only 1140 sq. mi. Under these circumstances considerable spillway capacity was required, and due to the narrowness of the gorge it was not considered practicable to make the power house itself a part of the dam. The power house was accordingly placed immediately below the dam, facing the stream, so that the axis of the nearest wheel was but 50 ft. from its headgate.

Earth Excavated for Less than Six Cents Per Yard

Modification of Cross-Section Taken Out and Adaptation to Conditions Reduce Cost of Swamp Dredging Below Estimate

DRAINAGE and flood work in District No. 9, Mississippi County, Arkansas, was estimated to cost \$1,155,000. By properly subdividing the work, and by enlarging the theoretical cross-section of the smaller ditches so they could be dug with the most economical tools, a contract price of \$979,950 was secured—15 per cent under the estimate, and at a minimum price of 5.7 cents per yard.

The work involved the construction of about 300 mi. of ditches and 35 mi. of levees for the flood protection and drainage of 300 sq. mi. of swampy alluvial land half covered with heavy timber. As described in the Engineering Record of Jan. 9, page 41, the dimensions of the channels were fixed to come within the economical limits of the largest excavating machinery available, and where the minimum dimensions did not permit excavation by the most economical plant they were increased, securing a reduction in the total price for a much larger quantity of work, through the greatly reduced unit cost.

MACHINERY AND EXCAVATING SECTIONS

The designs and specifications for the work, which involved 14,000,000 cu. yd. of soft earth excavation, were prepared with the idea of using floating dipper dredges. This tool is considered the most practical for excavating in these heavily timbered lands, where the machinery must be able to uproot large stumps. The minimum channel section is 14 ft. wide at the bottom, with 8 ft. depth and $\frac{1}{2}$:1 side slopes. The maximum section is of 50 ft. bottom width and has a cross-section of 800 sq. ft. The most economical machine for the smaller channels was a $1\frac{1}{2}$ yd. dredge installed on a hull 20 ft. wide and 3 ft. deep. Bids \$200 per mile cheaper were tendered for excavat-

ing the 14-ft. channel with this tool than for excavating a 6-ft. channel on any basis. The large dipper dredges used in excavating the 50-ft. channels have $4\frac{1}{2}$ -yd. dippers and an 85-ft. boom. Under the most favorable circumstances they have attained a maximum output of 120,000 cu. yd. per month.

The physical conditions were considered very favorable for the work, and great pains were taken to lay out the ditches so as to make the work desirable from the contractor's point of view. In most places the water line is at or a few inches above land surface a large part of the year. Most of the work is accessible by railroad and wagon road, so that coal can be hauled and barged to the plant. Nearly all plant-building sites are accessible for the delivery of material and plant by railroad. The local water is good for use in boilers, and the best grade of Southern Illinois coal could be purchased for about \$3.50 per ton f.o.b. railroad stations in the district when the contracts were awarded.

Each contract was laid out to comprise continuous ditching in one size of cross-section, and so that each could be dug by one machine within the three years' time allowed for completion of the work. The amount of excavation on each contract is large enough to justify the installation of economical plant without involving excessive overhead charges. Every effort was made to eliminate construction problems and to reduce the work to simple uniform operations under favorable conditions. Before the bids were opened a schedule of railroad excursions over part of the district was arranged under guidance of the engineer corps to enable contractors to examine the site, and provision was made for inspection trips for them on various logging railroads covering another portion of the territory.

CLASSIFICATION OF CONTRACTS

The excavation work was divided into sixteen parts offered separately to bidders, all of which were tabulated in the specifications, giving the units and other principal data, and also stating the engineer's estimate of actual costs. In the construction of dredged ditches having less than a 20-ft. bottom width it is required that the excavation shall be done at an average rate of 25,000 cu. yd. during the working season. On ditches with a bottom width of 20 ft. or more, excavation shall be at the average rate of 40,000 cu. yd. per month. Time is allowed for delays due to lack of water, and during the dry season between June 15 and Sept. 15, which is usually a dry season, contractors are not required to maintain this rate of progress.

In contracts 1, 2, 3, 4, 6, 7, 9 and 14 the smallest dredged ditches had a bottom width of 14 ft. and side slopes of $\frac{1}{2}$:1. This required the excavation of about 30,000 cu. yd. per mile. The contractors are permitted to excavate the ditches larger than required by the design unless specifically notified to the contrary, payment being made, of course, only for the required excavation. Each contract was separated into sections of 250,000 cu. yd. of excavation, and payments were made in full at the completion of each section, thus avoiding the expense to the contractor due to withholding the retained 20 per cent required by law until the completion of the entire contract.

Contract 4 is typical of the more unfavor-

able work, in that the ditches were small. The work lay through heavy woods, and a large part had to be dug upstream, the contractor having to build dams and pump water in order to float the dredge. Contract 16, let at $11\frac{1}{2}$ cents per yard, the highest priced work on the entire job, was about the only contract lying for the most part in open fields. It was planned to construct this ditch with dry-land machinery. Contract 13 was of the same general character, except that it lay in a heavily wooded territory in flat ground where water supply could be secured for floating a dredge. The difference in contract price between 7 cents per yard for work in heavy woods and $11\frac{1}{2}$ cents per yard in open fields represents the difference in efficiency between the floating dipper dredge and other types of excavating machinery. Contracts 5, 8, 10, 12, 11 and 15 were for large channels through very heavily wooded land. The contract prices ranged from 5.7 to 6.35 cents and include the clearing of timber from the right of way. On contracts 8, 10 and 12 the contract price also includes the construction of a levee with the earth excavated from the ditches.

PERFORMANCE OF LARGE DREDGES

The six contracts last mentioned are being constructed by three $4\frac{1}{2}$ -yd. dredges. No dredges of this size and type had ever been constructed, and the machines were more or less experimental. While on the whole they were well built, yet many details required working out by experience. There were numerous breakages of parts that had not been designed with sufficient strength, and delays due to these breakages had been a very serious loss to the contractors. Possibly one-third of the entire time since the machines began to operate has been spent in repair work. After a year's experience the machines are becoming standardized and dependable, but the loss of time and the heavy expense incurred in perfecting the type of equipment has gone far toward eliminating the profit which this work would otherwise have brought.

One of these machines operating steadily for a month will excavate about 120,000 cu. yd. On account of breakage, however, the average has been reduced to about 80,000 cu. yd. With an average excavation of 100,000 cu. yd. per month the work would be profitable at the contract price. The cost of these machines set up and ready for work is about \$40,000 each.

The work has been designed and its execution is being supervised by the Morgan Engineering Company, of Memphis, Tenn.

THE LARGEST SIMPLE LOCOMOTIVE yet built has been delivered at the Panama Pacific Exposition grounds and installed in the Palace of Transportation where it forms a part of the exhibit of the Chicago, Burlington & Quincy Railroad. The locomotive is 88 ft. long over all, weighs 206.9 tons and is fitted with automatic stocking apparatus, both steam and air power reverses and electric generating set. It was accompanied across the continent from the Baldwin works at Philadelphia by an attendant who converted the tender into temporary quarters with separate cooking and sleeping apartments. Hauling the locomotive as freight cost more than \$1000 and the journey occupied thirty-seven days owing to the necessity of routing it over certain lines whose curves were not too sharp for its long rigid wheelbase.

Wide Column Spacing Effects Economy in Factory Floor Area

Girders of 24½-Foot Span a Feature of Eleven-Story Steel-Skeleton Candy Factory for Auerbach Company

BY EUGENE W. STERN
Consulting Engineer, New York

ONE of the largest factory buildings in America built expressly for candy manufacturing has been completed at Eleventh Avenue and Forty-sixth Street, New York City, for the Auerbach Company. The owners desired a building which would embody not only the most approved arrangements for the needs of this business and for the safety and comfort of the employees, but

for automatically feeding the boilers through chutes and by mechanical stokers. The floors are figured for rather heavy loads—200 to 250 lb. live load.

Most of the lot being underlaid with good sound rock, very little difficulty was met in the foundations, except in the southwest corner, where the rock dipped suddenly off to about 40 ft. below the curb. The footings under columns were of steel grillages in two and three layers, no cast iron whatever being used.

SUPERSTRUCTURE

In the design of the superstructure, a number of considerations were important:

1. The spans were to be as wide as possible consistent with economy.

2. The columns with their fireproofing were not to occupy too much space.

3. The beams and girders were to be kept flush on the bottom in order to simplify the placing of overhead shafting and sprinkler pipes.

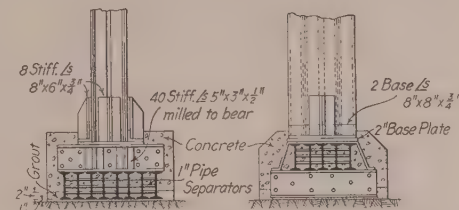
In order to determine the most economical spacing of columns various panels were studied, and it was found that either 18 or 24-ft. panels would work out best.

On estimating the cost of the longer panel it was found that while more steel would be used, there would be fewer foundations, fewer columns to fireproof, and more floor area, owing to the smaller number of columns. On making a careful comparison, considering all these factors, the longer span was found to be the more economical, and much more satisfactory to the owners. Attention is called to this fact because often structural designers do not consider more than the cost of the steelwork which goes into the construction, forgetting altogether about foundations, fireproofing, and the wasting of floor space. It will usually be found that where the cost of land is at all high, it will be better and more economical to space columns comparatively far apart.

In order to avoid the excessive depth in the floor girders which a spacing of 24½ ft. between columns would entail a scheme of cantilever girders straddling the columns was worked out. This proved very satisfactory, and enabled all the exposed beams and girders to be flush on the bottom and substantially of the same depth, 18 in. The cantilever arms varied between 5 and 6 ft. in length.

The detail of supporting brackets on columns is shown in the accompanying diagrams; the connections proved to be very stiff, since, during erection, there was practically no vibration in the building. Attention is called to the design of the driveway girders and also to that of the supporting columns.

The space between two pairs of driveway girders, which are 6 ft. deep, was utilized for the storage of water. These girders formed the sides of a tank and the bot-



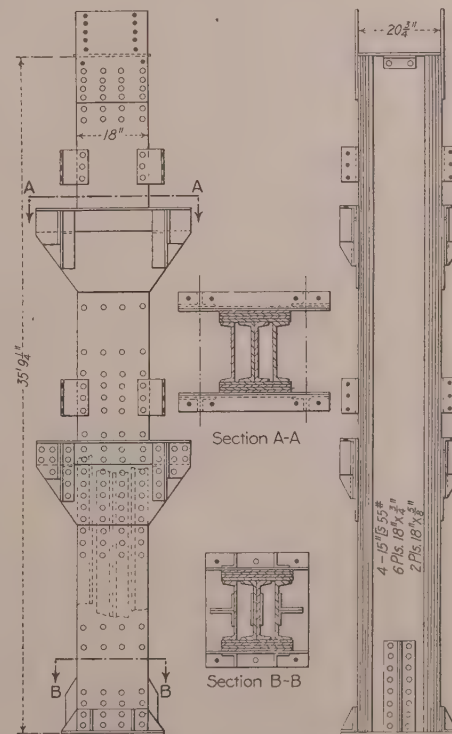
DETAIL OF STEEL GRILLAGE FOR COLUMN

tom was supported on 12-in. 40-lb. I-beams. All this steel was encased in stone concrete, waterproofed with ordinary five-ply tar felt. Storage space, which otherwise would have been wasted, was thus provided for 37,000 gal.

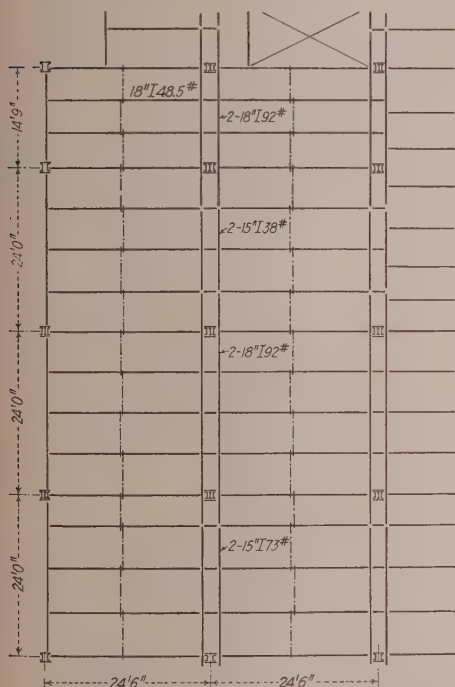
FLOOR CONSTRUCTION

The floors consist of 2-in. maple, laid on 1½-in. spruce on a 3-in. cinder fill, and a 4-in. cinder-concrete floor slab. The top floor of maple is laid with ¼-in. seams and ship-caulked with oakum. All exposed steelwork is covered with cinder-concrete fireproofing, 1 in. thick for beams and girders and 2 in. around columns. The floor and sides of the coal bunkers were of steel with reinforced stone concrete filling.

The architect was Robert D. Kohn, of New York. The steelwork was furnished by the Hay Foundry & Iron Works. The steelwork and foundations were designed and their construction supervised by the writer as consulting engineer.



DESIGN OF TYPICAL BRACKETED COLUMN

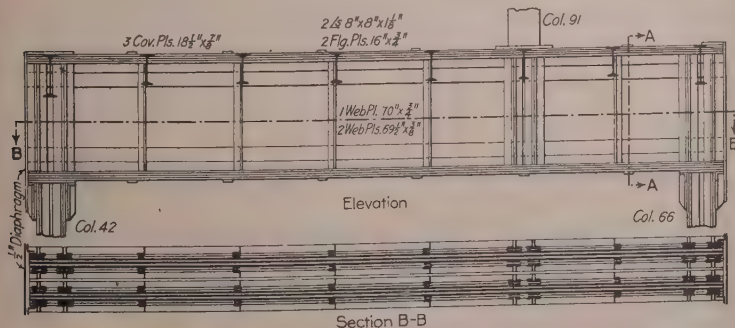


PART PLAN SHOWING FRAMING OF FLOORS

also the best that could be obtained in the way of fireproof construction.

GENERAL DESCRIPTION AND FOUNDATIONS

The building is 200 x 200 ft. in plan, and eleven stories high, having steel-skeleton construction with cinder-concrete floors and fireproofing. Façades are of brick. The spacing of the columns, 24½ ft. on centers, is somewhat greater than is customary in ordinary factory buildings. Through the building is a driveway about 32 ft. wide, over which the factory is carried on very heavy plate-girders. There is an elevated coal bunker having a capacity of 1000 tons



DETAILS OF TYPICAL BOX GIRDER FOR THE AUERBACH CANDY FACTORY

Urges Conservatism in Railroad Electrification

W. S. Murray Counsels Balancing of Saving in Operation Against Cost of Construction—Gives Costs Based on New Haven Work

CONSERVATISM in railroad electrification was urged by W. S. Murray, consulting engineer of the New York, New Haven & Hartford Railroad, in a paper delivered in Philadelphia Jan. 20 at a joint meeting of the Franklin Institute and the Philadelphia section of the American Institute of Electrical Engineers. According to Mr. Murray the desirable conditions of electrification must in each case be balanced against the high cost of construction. Partial electrification may impose a serious and unfair burden on the railroad. Proper administration is essential to the success of main-line electrification. Although the electric locomotive is normally more easily and cheaply maintained than the steam locomotive, overloading and other improper treatment may reverse the conditions as some operating men have found to their sorrow.

Mr. Murray's paper included an account of the development and operation of the New Haven electrification and cost and other statistical data. An abstract of the paper follows.

During 1913 on the electrified section of the New York, New Haven & Hartford Railroad 2,182,000 electric passenger locomotive-miles were recorded, representing 600,000,000 ton-miles. The route mileage electrified is 73, of which 61 is four-track and 12 is six-track, the total main-line mileage in single-track equivalent being 316. There are 184 mi. of yards, sidings and spurs, making a total of 500 mi. of single track. The present electric power supply is taken from a single station at Cos Cob, but it will shortly be supplemented at the east and west ends of the electrified zone. There are 100 passenger, freight and switching electric locomotives and sixty-nine multiple unit cars, all of which are maintained at one main electrical shop with facilities for inspection at various points. The electrification has cost more than \$15,000,000, although against this should be credited the value of 150 steam locomotives transferred to other parts of the system, the steel bodies of the multiple unit cars which would have been purchased even had not the electrification been undertaken, and other items of this sort.

Forty-eight locomotives are used in passenger service and the multiple-unit equipment at present comprises twenty-five motor cars and forty-six trailers. The average number of electric train-miles per day is about 6600, of which 1400 are made by multiple-unit equipment. The passenger locomotives make an average of 6200 mi. per day, some of the individual mileages being as high as 50 to 500. The multiple-unit motor cars make an average of 2100 mi. per day.

ECONOMICS OF ELECTRIFICATION

Success of main-line electrification is entirely dependent upon density of traffic. Economy can be secured by electrification in saving in fuel, saving in motive-power maintenance and repairs and saving in train-miles. There may be also assets created by electrification through, for example, reclamation of city terminal property after the removal of gas and smoke.

Experience has shown that a pound of coal burned under the boilers of a central electric power station and transmitted to an electrical engine will develop twice the drawbar pull at the same speed as if burned in the firebox of a steam locomotive. The maintenance and repair costs on electric locomotives of the straight alternating-current type are about one-half of those of steam locomotives of equal weight on drivers. The problem of electrification, then, depends upon the density of traffic in which these economies can be practised.

ADMINISTRATION

One of the essentially real conditions affecting the success of main-line electrification is administration. Electricity as an agent of power development is essentially different from steam. The electric locomotive is increasing in ruggedness, but it can never be the great mechanical brute that the steam locomotive is today. On the other hand, the steam locomotive can never reach into the zones of usefulness which are open to the electric engine.

It is possible to keep the maintenance and repairs of the electric locomotive down to one-half those of the steam locomotive under the most favorable conditions of steam maintenance, and in many cases below this figure. Due, however, to the peculiar nature of the electric engine, this can only be done by the most rigorous and careful inspection and conformity to rules of operation. If electric engines be treated as has been the custom of treating steam locomotives, then their repairs instead of costing less will cost far more than those of steam engines. The electric engine, like an overwilling horse, will, if permitted, work itself to destruction. The days are passing when the steam operating man points with pride to the electric locomotive as having been able to perform twice the duty for which it was designed and the next day wonders why it "blew up" on half load. Successful electrification, therefore, requires that there be in the administrative forces men trained to the necessity of a different viewpoint from that which has been developed in eighty years of steam service.

An inheritance by the New Haven of the old steam-locomotive enginemen for the operation of their electric engines is a case where the "tail of the dog wags the body." While it is a good argument that these men understand the roadbed and signals better than anyone else, this argument fails when enginemen without electrical experience or training can bid in the electric runs depending upon their seniority and records of service. It is a long time before the steam-locomotive engineman divorces himself from the fact that he is not operating a steam locomotive. Electrically trained men are therefore necessary, and one of the successes of electrification depends upon this feature.

NEW HAVEN OPERATING STATISTICS

The conditions applying to the New Haven electrification required that its motive power be designed to operate on both alternating and direct current. Further, on account of past inadequate shop facilities, heavy repairs have been necessary throughout the entire electric motive-power equipment since the new shops were completed. Last October the repairs to electric passenger locomotives cost 8.56 cents per locomotive-mile, while for November they

were increased to 10.61 cents. This fact is explained by the condition that all of the passenger engines had been undergoing general repairs, and invoices for material were passed in greater amount for November than for October. Many of the electric locomotives had not received a general overhauling since 1907, and during this time some of them have made more than 350,000 mi.

The records of the first ten locomotives of the alternating-current-direct-current type to be overhauled show an average cost of less than 5 cents per locomotive-mile. The first one overhauled has now operated 93,140 mi. at an average cost of 3.6 cents per locomotive-mile. The general figures of passenger-engine operating costs show a larger cost of maintenance than this and emphasize the lack of maintenance to which the electric locomotives were subjected in the early days of their operation. Had conditions permitted the electric passenger engines to be of the straight alternating-current type their average maintenance would probably not have exceeded 4 cents per locomotive-mile.

Electric energy consumption in the different classes of service ranges from 31.4 watt-hours per ton-mile for express trains to 90.2 for short-distance locals. Freight trains average about 33. The differences in the "power rate" constants for passenger service are due to the relative numbers of stops per mile. In the freight service allowance for the weight of the electric engine reduces the rate to 26 watt-hours per ton-mile and it may be said that 30 watt-hours is a reliable figure to cover electric freight operation on level track in a combination of fast and slow service.

CONSTRUCTION COSTS

The cost of electric locomotives of approximately 100 tons weight will, under present conditions of costs of labor and materials, vary between 18 and 20 cents per pound. This figure is practically irrespective of speed torque characteristics, a high-speed passenger locomotive and a low-speed switcher not varying greatly in cost upon a pound basis. Multiple-unit cars, now usually built of steel, do not vary greatly from these figures, but if anything would be slightly higher in cost per pound. A first-class, high-speed, 100-ton, straight alternating-current electric passenger locomotive, capable of handling a 250-ton trailing load in normal large-city suburban service, should cost \$40,000. A steam locomotive to do the same work would probably cost about \$15,000. For every electric engine purchased the railroad would be justified in making a capital investment of \$40,000 to cover the cost of electric power houses and transmission equipment necessary to supply the electric engine with current.

Costs per mile for six-track catenary construction of the compound type, that is, with an auxiliary messenger wire, with 300-ft. spans, are as follows: Tangent track, \$38,760; curved track, from \$43,000 for curvature under 1 deg. to \$59,230 for curvature up to 4 deg. Costs for four-track construction are \$25,490, and from \$27,550 to \$40,940 respectively, for two tracks, \$19,190 and \$21,610 to \$24,960, while the cost for two-track construction with curvature greater than 4 deg., requiring a pull-off pole, is \$34,450. The cost for two-track, single catenary is \$13,720 for tangent track and curves up to 2½ deg.;

\$15,110 for curves up to $3\frac{1}{2}$ deg. and 260-ft. spans; \$19,385 for curves up to $4\frac{1}{2}$ deg. with 200-ft. spans, and \$28,850 for those above $4\frac{1}{2}$ deg. with pull-off pole and 200-ft. spans.

The total cost of an anchor and section-alizing bridge, including steel, concrete, floor on upper deck of bridge, control apparatus and connections, and sectionalizing, are as follows: Compound catenary—six-track, \$14,000; four track, \$9,730; two-track, \$6,660; for single catenary—four track, \$9,020; two-track, \$6,120.

CONCLUSIONS

In conclusion, while the savings to be effected under certain conditions of electri-

fication may be considerable, on the other hand the construction investment necessary for these savings may be very great. Only a healthy condition of finance throughout the country will warrant the consideration of electrification. Partial electrification, such as that applying to yards only and no main lines, might prove a serious and unfair burden for a railroad to carry. The electrification of great railroad terminals in particular presents conditions in which the maximum cost is combined with a minimum direct return upon the invested capital; and without some reasonable assurance of adequate return it will be more difficult to secure the necessary capital for such improvements.

back of the obvious, of dissecting industry to its ultimate elements, will it be possible to place business on a more and more scientific basis.

The basic thought in Mr. Church's investigation is that factory management (and his discussion applies only to factories) can be resolved into five organic functions, designated as design, equipment, operation, comparison and control. To the elucidation of each of these functions he applies the three "laws of effort": (1) The systematic accumulation and use of experience; (2) the economic control (or regulation) of effort; (3) the promotion of personal effectiveness. The application of these laws to design, equipment, operation and control are readily seen by those familiar with modern methods of management, but the application to the function of comparison is not evident, until it is understood that under comparison are grouped all of the statistical helps to economical management—comparison with standards of records, of material, of equipment and labor performance, and of manufacturing costs.

It is interesting to note that despite the fundamentally different method of attack, the general impression left by the book is similar to that of other works on efficient management. This is undoubtedly due to the fact that all systems eventually resolve themselves into detailed analysis of all of the factors that can possibly affect manufacturing cost, followed by synthesis, using the data resulting therefrom. For its stimulating effect, therefore, the book will serve as well as previous works. To the student the book will make an especial appeal. The manufacturer new to the subject will want a book with more direct approach.

Literature

For the Civil Engineer and Contractor

New Publications

RAILWAY BELT HYDROGRAPHIC SURVEY 1911-12. By P. A. Carson. Water Resources Paper No. 1, Department of the Interior, Canada, Water Power Branch. Paper, $6\frac{1}{2}$ x $9\frac{3}{4}$ in., 551 pages. Illustrated.

BOW RIVER POWER AND STORAGE INVESTIGATIONS. By M. C. Hendry. Water Resources Paper No. 2, Department of the Interior, Canada, Water Power Branch. Paper, $6\frac{1}{2}$ x $9\frac{3}{4}$ in., 345 pages. Illustrated. Maps and plans in a separate folder.

MANITOBA WATER POWERS. By D. L. McLean, S. S. Scovil and J. T. Johnston. Water Resources Paper No. 7, Department of the Interior, Canada, Water Power Branch. Paper, $6\frac{1}{2}$ x $9\frac{3}{4}$ in., 214 pages. Illustrated.

TUMALO IRRIGATION PROJECT. By O. Laurgaard, project engineer. Final report on the construction to the Desert Land Board, State of Oregon. Paper, 6 x 9 in., 90 pages. Illustrated.

AMERICAN SEWERAGE PRACTICE. By Leonard Metcalf and Harrison P. Eddy. Vol. II. Construction of Sewers. Cloth; $6\frac{1}{2}$ x $9\frac{3}{4}$ in.; 564 pages; 181 illustrations. New York and London, McGraw-Hill Book Company. \$4 net.

PROCEEDINGS OF THE SIXTH NATIONAL CONFERENCE ON CITY PLANNING; held at Toronto, Ont., May 25-27, 1914. Cloth; $6\frac{1}{2}$ x $9\frac{3}{4}$ in., 361 pages.

THE PANAMA CANAL. By R. E. Bakenhus, Harry S. Knapp and Emory R. Johnson. Cloth; 6 x $9\frac{3}{4}$ in.; 257 pages; illustrated with maps, photographs and drawings. New York and London, John Wiley & Sons, Inc. \$2.50 net.

AN INTRODUCTION TO TOWN PLANNING. By JULIAN JULIAN. Cloth; $5\frac{1}{2}$ x 8 in.; 149 pages; 9 illustrations. London, Charles Griffin & Company, 5 shillings, net.

STANDARDIZATION OF NO. 200 CEMENT SIEVES. By Rudolph J. Wig and J. C. Pearson, Bureau of Standards. Paper; 7 x 10 in.; 51 pages, 7 illustrations. Washington, D. C., Superintendent of Documents.

NEW TIME SAVERS IN HYDRAULIC AND EARTH WORK. By C. E. Housden. Cloth; 5 x $7\frac{1}{2}$ in. Contains the authors previously published "Hydraulic Scales" and "Rapid Earth Work Calculation." London and New York, Longmans, Green & Company, \$1 net.

ELEMENTARY MATHEMATICAL ANALYSIS. By Charles S. Slichter, Professor of Applied Mathematics, University of Wisconsin. Cloth, 5 x 7 in.; 490 pages; 183 illustrations. New York and London, McGraw-Hill Book Company. \$2.50 net.

ELEMENTS OF HYDRAULICS. By S. E. Slocum, Professor of Applied Mathematics, University of Cincinnati. Cloth; $6\frac{1}{2}$ x $9\frac{3}{4}$ in.; 294 pages; 210 illustrations. New York and London, McGraw-Hill Book Company. \$2.50 net.

FLOOD PROTECTION IN INDIANA. By W. K. Hatt, Professor of Civil Engineering, Purdue University. Paper, 5 x $7\frac{1}{2}$ in., 51 pages. Illustrated. Indianapolis, Ind., Bureau of Legislative Information.

HYDRATION OF PORTLAND CEMENT. By A. A. Klein and A. J. Phillips, Bureau of Standards. Paper, 7 x 10 in.; 71 pages; 19 illustrations. Washington, D. C., Superintendent of Documents. 20 cents net.

MEMORANDUM OF SUGGESTIONS UPON MAIN PROVISIONS REQUISITE TO AN ADEQUATE COMPULSORY WORKMEN'S COMPENSATION LAW. Issued by the National Civic Federation, New York City. Paper; 8 x $10\frac{1}{2}$ in.; 6 pages.

HYDROELECTRIC SYSTEM OF TENNESSEE; West Tennessee Gullied Lands and their Reclamation, and the White Phosphates of Tennessee. Published in Vol. 5, No. 1 of the Resources of Tennessee, issued by the State Geological Survey, Nashville, Tenn.

Book Reviews

Materials of Machines

Author, Albert W. Smith, Director of Sibley College, Cornell University. Cloth, 5 x $7\frac{1}{2}$ in.; 215 pages; 36 illustrations. New York, John Wiley & Sons, Inc. \$1.25.

This book has been thoroughly revised and much new material added. It deals only with the metals used in machine construction and is divided into two parts; the first part describes the processes by which the materials are produced, and the second takes up the properties of the materials themselves. Thus we have in the book a brief outline of the metallurgy of iron, copper, zinc and other metals, together with a description of the furnaces used, a few pages devoted to methods of testing and a chapter each on cast iron, steel and non-ferrous alloys. The space devoted to the heat treatment of steel is very brief, and the chapter on the selection of materials for machines is very elementary and not in keeping with other parts of the book. For a small book covering a limited field it is well worth while; no useless material is used, and the information given is reliable.

Science and Practice of Management

Author, A. Hamilton Church. Cloth, 5 x $7\frac{1}{2}$ in., 536 pages. New York, Engineering Magazine. \$2.

Those who know of Mr. Church's studies of production costs, and particularly of his method of distributing burden, will expect in this book a valuable discussion of management problems. They will not be disappointed, albeit the line of approach differs radically from the "scientific management" studies of Emerson, Taylor and Gantt. These pioneers have attacked the problem from what may for purposes of comparison be called the obvious practical side. They saw distinct management problem, and they sought the immediate solution. Mr. Church has chosen to go deeper. He has sought the irresolvable fundamentals of management. The result is a volume that will hold the attention of economists and students better than that of manufacturers. This should not be taken as a disparaging statement, for only by getting

Handbook of Hydraulics

HANDBUCH DES WASSERBAUES. Author Hubert Engels. Two volumes. Paper, $7\frac{1}{2}$ x 11 in., 1499 pages; 1623 text figures. Leipzig and Berlin, Wilhelm Engelmann. 100 marks net (\$25).

Germany, involved in a war that is the worst in modern history, still continues to contribute its share to the progress of science. One of its latest contributions is an extensive work on hydraulics written by Hubert Engels, professor at the Technical University in Dresden, geheimer hofrath and doktor ingenieur h.c. Professor Engels began his experiments in 1890 on the movement of sand, clay and gravel, etc., by flowing water and his successful activities led, in 1900, to the establishing of a hydraulic laboratory at the Technical University of Dresden, especially adapted to the study of rivers and river improvements. Later on this laboratory has been extended so that it is now one of the best in the world.

The aim of these volumes, which the author calls a handbook, is not only to give the theoretical investigations of the subjects, but also to show the practical results thereof. To make this possible a large number of examples of works in operation have been given. The experience of Professor Engels' long activity as a teacher of hydraulics, twenty-seven years, together with his work as consulting engineer, have made him especially able to write a book of this kind. All phases of hydraulic construction have been treated in a thorough manner except the development of water powers. German literature already possesses a number of very good textbooks on this subject, and a thorough treatment of

it here would have unnecessarily burdened the book.

In the chapter dealing with movable dams is given a comparison between Tainter gates and rolling dams made in connection with the construction of a dam in the Landwehr canal at Berlin. It was found that both types have the same advantages, but that the cost of rolling dams is somewhat higher. Rolling dams and Tainter gates are pronounced as being the best available types of movable dams and a more general adoption of them is predicted.

Parts 1 and 2 of the first volume contain meteorologic and hydrometric data and have five subdivisions—the earth and the water, movement of water, flowing and standing waters, the ocean, and hydrometric work. Part 3 deals with rivers and contains three chapters—Formation and characteristics of rivers, projecting river regulations and the construction of structures for river regulation. In part 4 there is a chapter on dams in rivers and another on reservoir dams and water-power plants. Part 5, entitled "Flood Protection," treats on shore protec-

tion and levee work. Part 6 deals with agricultural hydraulic construction and has the following subdivisions: Ground water and the growing of plants, drainage, irrigation, examples of larger drainage and irrigation districts, culverts through levees and their gates and the treatment of swamps.

Volume II begins with part 7, which deals with ships and their form and propulsion for both ocean and canal traffic, as well as lighthouses, buoys and other marks for navigation. Part 8 describes ship locks and their appurtenances. Part 9 treats the canalization of rivers and canals, while part 10 deals with harbors.

The chapters dealing with locks and harbors are the most extensive, because of their importance. The illustrations are almost entirely line drawings, which have enabled the author to show exactly what he desires to emphasize. The price is somewhat high as compared with prices of technical books in general, but the value is correspondingly high. The book is an invaluable contribution to technical literature.

borough passenger travels only a short distance, as you mentioned in your editorial. Comparative death rates per passenger-train-mile would show up very differently.

There has never been a great catastrophe on the subway. Neither has there on many of the large steam roads in the same time. Certainly the subway offers possibilities of sending more people to eternity at one stroke than the steam road. Let most of the occupants of even four cars meet death in a single rush-hour subway accident, and "1 in 842,000,000" will be heard no more.

Operation of the subway is simple compared with that of steam road. True, the subway handles many more trains, but they are standardized. On a given track they all go in the same direction, are of the same size and weight, are run by the same power, make the same stops. Except at Ninety-sixth Street and a few other junction points there is no switching. Each train can proceed from terminus to terminus without dodging any other train. In the subway everything is shielded from the elements. Even on the elevated lines the elements are never able to put forth their worst efforts, and the telephone and the emergency outfit are always at hand in case of trouble.

Contrast this with steam-road operation. There are trains of all sizes and speeds—local freights, tonnage freights, fast freights, milk trains, local passenger trains, ordinary fast trains and fliers, not to mention work trains, inspection trains, extra sections and other specials. On single-track roads they must weave in and out in both directions with the aid of sidings. On multiple-track roads the local freight must keep out of the way of the fast freight, which in turn must take a siding for the accommodation train, all of which are overtaken by the flier. On a busy division probably the trains never run in exactly the same sequence two days in succession. Every delay to a single train forces the dispatcher to reconstruct his whole scheme of operation. If the delay occurs between stations he can only speculate as to what has happened to his train and when it will be remedied, but the other trains must be kept going. In spite of fog, cloudbursts, floods, hurricanes, blizzards, avalanches, the trains must be kept moving so long as they can be found. When the wires go down, instinct must guide. When the water comes over the tracks the engineman must feel his way along.

The Interborough escapes most of the hardships of real railroading. The figures given out are none the less true, but the inference that the steam roads are 300 times as dangerous as the Interborough is unfair to the former.

New York City.

G. W. WOLCOTT.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Girderless Concrete Slabs

SIR: In connection with Chicago's building ordinance mention has been made of the treatment of rectangular slabs supported on all four sides and reinforced in two directions. The writer is reminded of a table he once made use of to simplify the computations for a building made up largely of such panels of varying proportions. The Chicago ordinance provides that for rectangular slabs "the distribution of the loads in the two directions shall be inversely as the cubes of the two dimensions." Evidently this must be taken to mean the total loads, which shall be considered as coming upon strips of slab 1 ft. wide.

Now for equal deflections and for strips of slab of equal width and depth the total loads vary inversely as the cubes of the lengths of the strips, or the loads per square foot vary inversely as the fourth powers of the lengths. That is,

$$r = L^4 / (L^4 + B^4)$$

where L and B denote the length and breadth of the panel, respectively, and r the proportion of the load per square foot which is carried by the shorter span. If $L = 18$ ft. and $B = 15$ ft., then $L/B = 1.2$ and $r = 0.67$.

Tables are available giving for different values of L/B the corresponding values of r . It is to be observed, however, that in the example cited 0.67 does not represent the ratio of steel across the slab in terms of the total steel. The value 0.67 is to be used to find the bending moment and the consequent depth of slab and area of steel

required in the shorter span. Then to get the amount of steel at right angles to this, multiply this amount by $[(1.00 - 0.67)/0.67] \times 1.2$. Or, $r' = B^4/L^4$, where r' = the ratio that the amount of long-span reinforcement bears to the amount of short-span reinforcement, per foot of width. (See table.)

These relations, of course, do not hold for a load close to one beam only. The resulting condition for a uniform load is that the middle strips, both longitudinal and cross, are loaded to a maximum of about 25 per cent heavier as regards moment than the foregoing computation shows, while those strips lying parallel and close to a beam carry very little, and this load may as well be assumed to come upon the bent-up portion of the slab rods over the beams, which in this system play a most important part.

After finding the load distribution as above, it would be conservative, in the writer's opinion, to use a bending moment to $wl^2/12$ to $wl^2/16$ for the bottom steel midway between supports, depending on the proportion of live to dead load, and $wl^2/12$ as usual over supports, in continuous spans.

DAVID F. STOCKBRIDGE.

Oklahoma, Okla.

A Good Record, but Not Extraordinary

SIR: Your editorial "Tardy Use of an Envious Record" in the issue of Jan. 23, page 95, in which you commend the Interborough Rapid Transit Company, of New York, for its seemingly extraordinary safety record, should be taken with a grain of salt. The comparative figures given out do not take into account the herding of passengers on the subway and elevated lines. A train carrying 2000 passengers packed to suffocation is hardly more likely to be wrecked than one carrying 300 passengers decently seated. Furthermore, each Inter-

CALIFORNIA HIGHWAYS totaling 2150 mi. have been surveyed since 1912 under the act that set aside \$18,000,000 for State highways. Of this total, plans and profiles have been made for 1164 mi., including 9868 mi. on which contracts have been let (counting work on a day-labor basis under this head), and of this latter figure 620 mi. had been completed by Jan. 1, 1915. These figures are exclusive of mileage constructed within the boundaries of incorporated cities or in any of the several county systems not yet taken over by the Highway Commission, hence the mileage represents the work of the commission only and by no means covers all the road work within the State.

Ratio of sides of panel	Proportion of unit load carried by short span	Factor
L/B	$r = \frac{L^4}{L^4 + B^4}$	$r' = \frac{B^4}{L^4}$
1.0	0.50	1.00
1.1	0.59	0.83
1.2	0.67	0.69
1.3	0.74	0.59
1.4	0.79	0.51

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, and should be accompanied, if possible, by photographs or sketches.—EDITOR.]

Twenty-Ton Valve Lowered Down 250-Foot Shaft in 20 Min.

By R. W. GREENLAW

Grant Smith & Co. and Locher, New York

TWO 66-in. manganese bronze gate-valves, each weighing 20 tons and requiring a 20-horse truck for its transport through the streets of New York, were set in the city tunnel of the Catskill aqueduct at the bottoms of shafts 250 and 200 ft. deep. The overall dimensions of the valves are, roughly, 14 ft. high, 7 ft. wide and 4 ft. from base to face of outlet. To transport these valves from the freight station to the shaft and to lower them presented an interesting problem. Each valve was loaded by a traveling crane on a truck, hauled to the shaft, and unloaded by the usual means of rollers and blocking.

A small auxiliary hoist was provided for use at the shaft while the regular hoist was rigged to set the valve. The mouth of the shaft was then covered with I-beams, and the valve moved over it on rollers. The valve was then raised to a vertical position by means of special tackles, so that the lowering hitch could be put on it. The lowering tackle consisted of about 1600 ft. of $\frac{3}{4}$ -in. cable rove through two 3-sheave steel blocks, the running and leading to the 5-ft. diameter drum on the regular shaft hoist. As this drum was scored for a $1\frac{1}{8}$ -in. cable, it was necessary to lag it with $\frac{7}{8}$ -

in. wood strips. The valve was suspended by two $1\frac{1}{8}$ -in. cable slings, each passing around one 66-in. outlet, and through the large shackle. Since this suspended the valve at a point below its center of gravity it was necessary to hold the top in position by fastening the I-bolt screwed in the large sleeve at the top of the valve to the main shackle by several loops of small cable. Also, to prevent the valve-stem from lifting and allowing possible lateral movement or bending, this I-bolt was tied down to the valve body with a $\frac{3}{4}$ -in. cable. The cable of the auxiliary hoist was made fast at the bottom of the shaft, and a piece of rope was looped around it and fastened to the valve. This loop slid down the cable as the valve descended, and prevented any twisting of the tackle.

The rigging was first tried out by lowering a light casting which adjoined the valve. The valve was then lifted, the beams over the top of the shaft removed, and the valve lowered to place in about 20 min. The electric shaft hoist was provided with a motor brake as well as the drum brake and these were used alternately to prevent overheating. The lowering was done continuously, and only as the load neared the bottom was there any noticeable rise in temperature. Just before reaching the bottom of the shaft the valve was swung by means of an auxiliary tackle about 6 ft. to one side and landed on the base plates. The final adjustments were made by jacks.

Sewer Tunnel in Clay Driven with Simple Equipment in Eight Weeks

SIMPLE but effective methods were adopted for driving a 1000-ft. tunnel through a clay hill to carry a 12-in. outfall pipe of the Alton Illinois sewer system. Shafts were sunk to grade on the center line at 200-ft. intervals. They were 4 x 8 ft. in cross-section and braced with oak timbers. Two shafts were worked at the same time. Over each was placed a light derrick handling a 5-cu. ft. wooden bucket. A double-drum hoisting engine placed midway between the shafts operated both derricks. This arrangement permitted work to be carried on from four headings.

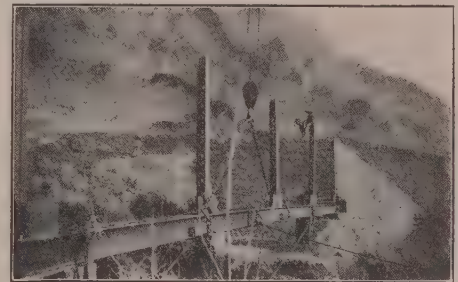
The tunnel was 6 ft. high and 3 ft. wide, and was sheeted on the top and sides with 3-in. oak as the work progressed. One man worked at the heading and one wheeled the spoil in a wheelbarrow to the shaft and dumped it in the bucket. When the tunnel had been driven half way toward the next shaft work from that end was stopped, so that the headings usually met very close to the center. A blower, run by a 1 1/2-hp gasoline engine, had to be used to supply fresh air to the headings. One fan furnished air enough through 3-in. pipe lines for all four headings.

When a continuous length of tunnel was finished, the cast-iron pipe was lowered at the shafts, dragged to place with a runner line, calked and backfilled. The hoist and derrick were then moved up and two new shafts started. Work continued night and day, the crews working in three shifts of 8 hr. each. The tunnel was driven and

pipe laid in eight weeks. The cost of the 1000 ft. of tunnel is estimated by the engineer, J. E. Schwaab, to be \$10,000. The construction was carried out under the direction of Mr. Schwaab by Charles E. Van Wormer.

Contractors Span 180-Foot Canyon Without Using Falsework

SOME years ago a 114-ft. single-track deck bridge was erected on the Mexican Central Railway over a canyon 180 ft. deep, where the use of falsework was im-



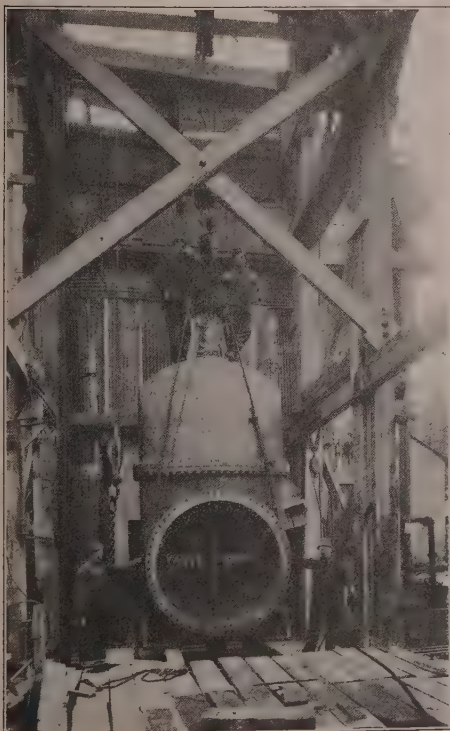
BOTTOM CHORD IN PLACE AT CANYON CROSSING IN MEXICO



COMPLETING BRIDGE ERECTION BY LOWERING TOP CHORDS FROM DERRICK CAR

practicable. It was originally planned to lift each truss, complete, into place by means of a derrick car built for this purpose. This car was designed to carry a 45-ton load on the end of a 68-ft. boom, but the condition of a new earth fill behind the abutment at one end of the structure, on which the car had to stand, was such that it was considered hazardous to carry out the plan.

The chords were riveted up near the crossing, and the posts were bolted to the bottom chords. The structure was a Warren bridge with sub-verticals. Each bot-



TWENTY-TON GATE-VALVE READY FOR 250-FOOT DESCENT INTO CATSKILL AQUEDUCT SHAFT

tom chord was trussed and then lowered into place. It weighed 18 tons and deflected fully 22 in. when resting on its pin bearings, but this deflection, which was determined by slackening the boom falls just long enough to make the measurement, was taken up by the turnbuckles of the temporary trussing before the falls were released. The top chords were then lowered into place, steamboat ratchets connected at the panel points, and the bottom chord drawn up into place. The diagonals and end cross-frames were inserted before the derrick falls were loosened and the structure allowed to settle into place. The work was done by the Missouri Valley Bridge & Iron Works, and H. N. Peck was inspecting bridge engineer for the railway company.

Rapid Trench Excavation at Canadian Camp Follows War's Call

FROM 8 a. m. on Nov. 25 to 8.30 a. m. on Nov. 27 a trench excavator at Medicine Hat, Alberta, dug a ditch 3590 ft. long, removing 3852 cu. yd. of material. The mini-

formed but 4.1 per cent of the total expense of laying the line, 86.1 per cent of which was spent for the materials used. The cost of the extension to the pipe line is divided as follows: Engineering and time-keeping, \$63.73; excavation, labor only, \$150.41; backfilling, \$134.80; pipe laying and hauling, \$158.15; materials, \$3171.66; total, \$3678.75.

Oxy-Acetylene Welding Eliminates Joints in Gas Mains

GAS mains in Chicago are being laid in continuous lines without joints by methods which might prove adaptable in water-works construction. The sections are welded together to eliminate joint leakage and subsequent maintenance cost. With skilled oxy-acetylene operators it is claimed that the strength of the average welded joint ranges from 80 to 95 per cent of the strength of the pipe.

In a typical job the pipes are strung along on top of the ground outside of the trench. Two or more lengths are butted together

desired angle. In one of the photographs is shown an emergency welding job on a drip, which, as sent to the point of installation, was found at the last minute to have 10-in. instead of 12-in. connections to fit the 12-in. main.

The work happened to be in a crowded street where it was impossible to open much trench at a time. Taking a short length of 12-in. pipe the operator cut it in two, inserted one piece in each of the openings and welded them in place. The entire job took only a few hours and the cost for gases and labor was slight.

Certain cost figures compiled by the makers of the Oxweld apparatus used in Chicago are as follows: For 4-in. butt-welded pipe, 43.5 cents per joint. The segregation was 15 min. labor, 7.5 cents; 8 cu. ft. oxygen, 16 cents; 7 cu. ft. acetylene, 14 cents; 1/2 lb. filling wire, 6 cents. Six-inch pipe welds cost 57 cents each; 8-in., \$1.055; 12-in., \$1.57, and joints for 16-in. pipe, \$2.21. For the last named pipe 1 1/2 hours of labor cost 45 cents; 40 cu. ft. oxygen, 80 cents; 36 cu. ft. acetylene, 72 cents, and 2 lb. filling wire, 24 cents. An 8-in. pipe was welded



LONG SECTIONS OF WELDED PIPE MAY BE LOWERED TO PLACE IN TRENCH IN ONE OPERATION



AN EMERGENCY WELD RECTIFIED A MISTAKE IN A DRIP BOX WITH CONNECTIONS TOO SMALL

mum dimensions of the trench were 8 ft. deep by 40 in. wide. The ditch was dug to extend the city water main to a group of buildings where the Alberta cavalry was being concentrated. The first 500 ft. of ditch consisted of hard, dry tough gumbo, containing numerous boulders as large as 3 cu. ft. The next 2000 ft. was of much lighter material, and was ideal for the operation of the machine. The remainder of the ditch was in sandy soil, which caved so that the sides had to be sliced and the material removed by the excavator.

The excavator, which is an Austin gasoline-driven trenching machine owned by the city of Medicine Hat, completed this ditch in 49 1/2 hr., elapsed time. The actual operating time was 44 hr., as 4 1/2 hr. were taken up in making repairs. In the 10 hr. from 7 a. m. to 5 p. m. on Nov. 26 the excavator traveled 1150 ft., an average of 115 ft. an hour. Including the time lost the average speed of the machine was 72 1/2 ft. per hour. The machine consumed 81 gal. of gasoline in digging this trench. The cost of excavating per cubic yard was 3.9 cents, and the cost per linear foot of trench was 4.16 cents. The cost of digging the trench

and welded by the operator, who is assisted by two helpers, one at each end of the section, who turn it with chain tongs or other devices so that the operator is always welding on top of the pipe—a position in which the fastest work can be accomplished. Pipe may be obtained cut at a bevel, in which case the two pipes are butted together, forming a V-shaped opening of about 60 deg. It is said to be preferable to procure pipe cut in this manner as the weld can be made quicker, at less cost, and with the use of less filling material.

Among the advantages claimed for this method of laying are these: It is practical to use long lengths of pipe, 40 ft. not being uncommon. Lighter pipe is feasible as no allowance need be made to permit threading. In open country it is not unusual to weld up 1000 ft. of pipe at a time, and one case is reported where 100 lengths of 8-in. pipe each 40 ft. long were welded into one section before lowering into the trench. Some engineers permit the pipe to be dropped into the trench, but usually it is lowered by ropes or chains.

With the cutting blowpipe holes are cut at any point and laterals welded on at any

into an 8-in. main to form a tee at a cost of \$3.04. A 6-in. 60-deg. Y required 10 min. to cut and 45 min. to weld. The total cost was \$2.14.

Electric Car Heaters Aid Cold Weather Concreting

BY putting electric car heaters to the novel use of warming concrete during construction in cold weather, the Salt Lake & Ogden Railway was able to complete 2937 ft. of street track last November. The work consisted primarily of 7-in. 80-lb. T-rails on box-girder ties supported by a concrete base. The concrete was poured through chutes direct from the mixer to the track. Electric car heaters were then installed at intervals of 10 ft. and connected ten in series on a 720-volt circuit. Canvas was stretched over the green concrete and the heaters were placed in circuit with the trolley wire by means of a fishpole connection. In this way the entire mass was kept warm until the concrete had set. The work was done under the direction of Julian M. Bamberger, vice-president of the railway company.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Impact of Street Cars Breaks Large Water Main

Loads Transmitted Directly to Pipe by Concrete Track Foundation and Ducts Cause Rupture of 30-Inch Line Which Floods Streets

Loads from passing street railway cars, transmitted directly to a 30-in. water main of New York City's low pressure distribution system through the medium of the concrete foundation of the tracks and a line of concrete-encased electrical ducts below them—the rigid duct structure resting directly on the top of the main—caused a break on the night of Feb. 2 which flooded streets and cellars in the vicinity of Forty-second Street and Eighth Avenue, ripped up an extensive area of wood-block pavement and tied up traffic on the street car lines. The break occurred at 10.30 p. m. and it was 4 o'clock the next morning before the flow had entirely stopped.

The water released by the failure of the pipe did not make its appearance directly above the point of rupture, but apparently followed an underground course of least resistance, crossing Eighth Avenue diagonally in a northeasterly direction and emerging directly below the street car tracks, 50 ft. or so north of Forty-second Street. The undermining of the street was not sufficiently serious to cause any marked subsidence of the car tracks, which were blocked up to carry the traffic. The wood-block pavement, however, was heaved up in the immediate vicinity and broken sections were observed as far as a block from the break. The water after floating the wood-block pavement apparently forced its way between the blocks and the concrete foundation and acted like a wedge, raising large sheets from the base.

It was impossible to reach the broken section by way of the underground path which the water had followed in reaching the street surface. Col. Merritt H. Smith, chief engineer, and William W. Brush, deputy chief engineer of the Department of Water Supply, Gas and Electricity started gangs of men excavating at three of the street corners in an effort to reach

the point of rupture. When the break was located there was found a 9-ft. split section of pipe on a curve.

The relation of the pipe to the sub-surface structures of the railway system left no doubt as to the cause of the accident. The track was supported by a concrete base which rested upon a line of electrical ducts sheathed in an envelope of concrete. The rigid duct structure had been bearing upon the top of the pipe so that the impact caused by the passage of cars and vehicles along the street was transmitted directly downward to the cast-iron pipe.

Canadian Railway Bridge Survives Dynamite Shock

Little Damage to Canadian Pacific Structure Results from Explosion Set off by Alleged German Army Agent to Stop Transport of War Supplies

The attempt on the part of an alleged agent of the German army on Feb. 2 to destroy with dynamite the Canadian Pacific Railway's bridge near Vanceboro, Maine, and so block a route over which war supplies were being



Photo Underwood & Underwood

CANADIAN PACIFIC RAILWAY BRIDGE WHICH WITHSTOOD DYNAMITE'S SHOCK

transported, resulted in comparatively little damage to the structure. From J. M. R. Fairbairn, assistant chief engineer of the Canadian Pacific, the Engineering Record has received a dispatch stating that the damage to the bridge, a 150-ft. through-truss span on stone abutments, consisted in injury to one end batter post, one steel stringer and a few ties. Traffic was delayed only 20 min. and temporary repairs were finished on the night of Feb. 2. The permanent repairs, Mr. Fairbairn reports, will be completed in a few days.

New York's Snow-Fighting Plan Has First Test

The first opportunity for testing the "snow-fighting" plan of John T. Fetherston, commissioner of the New York Street Cleaning Department, was presented this week by a severe snow and sleet storm. The fundamental feature of the plan is the removal of snow while the storm is in progress. Under the scheme of organization, which has been described in detail in the Engineering Record, 3000 of the department's regular employees and 12,000 emergency men were in action at 3 a. m., two hours after the call to work had been issued. So tightly had rain and sleet packed the snow which had fallen initially that the frozen mass weighed 35 lb. per cubic foot, which is from three to six times the weight of what is ordinarily classified as "snow." This condition was a great handi-

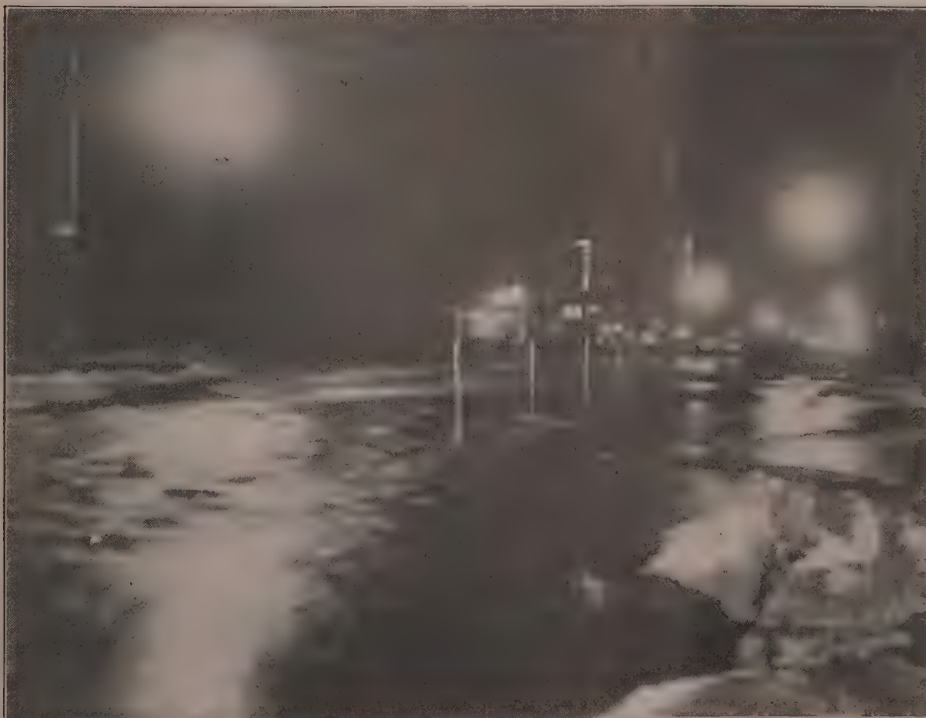


Photo American Press Assn.

A BROKEN 30-INCH WATER MAIN FLOODS STREETS OF NEW YORK CITY

cap to the speed of the work. None of the workers was able to benefit by the bonus system, which is a feature of the snow-fighting scheme. The solid, compact nature of the material also prevented any general use of sewers for snow removal, another prominent feature of Commissioner Fetherston's plan. However, a number of the large size sewers were utilized, but it was considered inadvisable to risk clogging the smaller drains by chunks of the heavy, icy material.

Western Society Protests Against Abuse of Investigating Engineers

Following "a torrent of fretful rebuke and personal insinuation" by certain members of the Sanitary District, by the Chicago City Council and by the newspapers, against the individual members of an engineering commission investigating the water power development of the Sanitary District of Chicago, the Western Society of Engineers passed resolutions on Feb. 2 deprecating the attempt to abuse engineers who were apparently trying to do their duty to the public in setting forth the facts as they found them.

The controversy concerned the commission's conclusion that higher rates for electrical current should be charged the city to make the Lockport hydroelectric plant stand on its own feet. The interests opposed to higher rates vented their spleen on the engineers, Lyman E. Cooley, L. K. Sherman, W. A. Artingstall and John Ericson. The society made it clear that it did not enter into the merits of the report, but did deprecate the way the engineers were treated.

The Engineer's Duty

For the benefit of the public officials, who were conspicuous in the controversy, the society stated its ideas with reference to the proper relations with engineering advisers, a matter it considered of vital import to the public welfare, as follows:

1. That an engineer's first duty to his client is to tell him the truth, no matter where it may lead, or how unpalatable it may be.
2. That engineering and engineering economics are subject to natural laws which cannot be altered to suit the whims of human nature.
3. That the most serious disgrace that can come to an engineer is to conceal, pervert or distort natural and economic law, either to please a client or temporarily advance his own interests, and so ultimately lead his client into difficulties.
4. That an experienced engineer of standing ranks as a confidential professional adviser, feeling keenly his responsibilities, and whose integrity and conscientiousness when properly established, should be appreciated and upheld by his client.
5. That engineers, while not infallible or superhuman, are more apt than laymen to be right in their findings on engineering facts and economic truth connected with engineering matters.

Finally the society pointed out that if the findings of an engineering report are open to question, there are a number of proper and dignified procedures that can be adopted to check its conclusions.

Illinois Utilities Commission Handles 3000 Cases in 1914

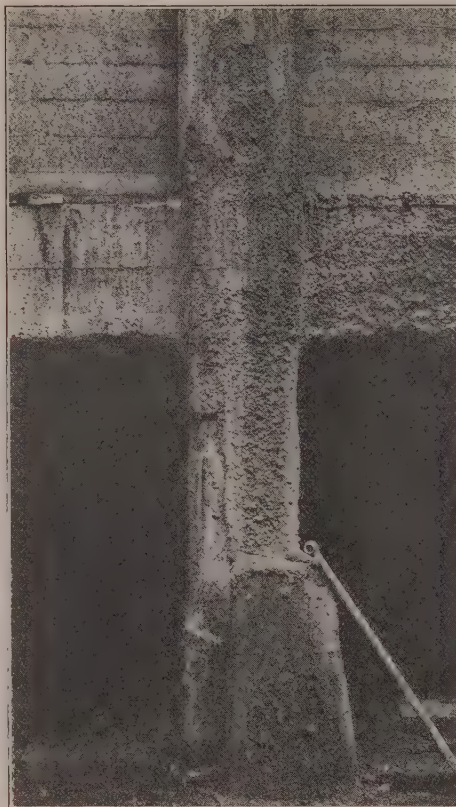
The State Public Utilities Commission of Illinois has closed its first year of work and reports receipts of \$510,173 and expenditures of \$180,000, including all salaries and the fitting up of offices in Springfield and Chicago. Over 3000 cases were considered during the year and approximately 500 formal cases were heard. Eighteen appeals were taken from the decision of the commission. Nine of these appeals were heard in the circuit court of Sangamon County at Springfield and in no case was the decision of the commission reversed.

Hot Chemicals and Concrete Formed Slag at Edison Fire

Rumors That Concrete Had Fused are Disproved by Investigations of Engineering Record's Representative

Wild rumors were in circulation in New York City last week that concrete at the plant of Thomas A. Edison, Inc., at West Orange, N. J., had fused in the fire of Dec. 9 and "run like water." As it was difficult to believe these rumors, a representative of the Engineering Record was sent to the plant to examine the "fused concrete."

The phenomenon had taken place in Building 12, which had been used for the storage of chemicals. As far as could be ascertained the chemicals were soda, potash, formaldehyde,



SLAG FORMATION; NOT "FUSED CONCRETE"

carbolic acid, orthocresol and others. The wooden barrels and boxes were quickly consumed by the fire and the first story, which has small windows near the ceiling only, then contained a boiling mass of chemicals, which became so turbulent as to boil over the window sills.

In the meantime the fire in the basement, which is about 10 ft. high and located above ground, had become hot enough to make the concrete practically incandescent. The boiling chemicals pouring over this superheated concrete combined with the latter to form a silica slag, greenish in color, which on the underside of the beams congealed into stalactites. The accompanying photograph shows the slag formation on one of the exterior columns and adjacent beams of the first floor. The concrete pedestal in front of the column served as one of the foundations for a frame building, which was completely destroyed.

Hole Burnt Through Slab

The action of the chemicals on the slab of the first floor system was similar to that on the exterior girders and columns, in one place eating a hole through the slab. That the action was from the top of the slab and was not due to the gases in the basement is shown by the fact that the edges of the hole are practically vertical, while if the hole had

been burned from below these edges would have been tapering, thus making the hole at the top of the slab smaller than at the bottom.

The superheated gases from boiling chemicals in the basement had a disintegrating action on the underside of the slabs and beams. A slag was formed, and "stalactite" formations are in evidence practically everywhere. In places the steel reinforcement was laid bare, and in such cases is covered with a bluish slag. This slag is very hard and brittle and has a consistency similar to that of the common hammer slag, formed when iron or steel is worked on an anvil. In no instance has the steel fused or melted, which seems to be a proof that the concrete did not fuse. On the ground below the hole in the slab there is a large pool filled with a greenish fluid. This fluid is still dripping through the hole from the first floor and in places where it drops on the steel reinforcement chemical action is evident. Just what the fluid contained could not be determined. The whole building smells strongly of carbolic acid.

All Stalactites Are Not Slag

The interior of the basement is blackened by smoke and it is impossible to tell by mere observation whether or not all the stalactites are of slag. Some of them are not, as discovered by the representative of the Engineering Record by breaking off a few. The chemicals have run down through holes for lighting wires and formed stalactites, the interior of which is white with a tinge of yellow in places. On the outside of the building, where such chemical stalactites have been exposed to the weather, chemical action has taken place and the soot has been removed. These stalactites seem to be either pure potash or soda or possibly a combination of both.

After the discovery of this disintegration in Building 12, a careful examination was made of the other structures, with the object of learning whether or not similar action had taken place elsewhere. It is stated that in Building 24 small stalactites have been found along beams and girders in the ceiling of the third floor, where large quantities of wax for phonograph cylinders were stored. These stalactites have not been examined, but it is believed that the action was similar to that in Building 12.

The committee of the National Board of Underwriters, which is investigating the fire, has asked the co-operation of the Bureau of Standards in investigating the action of the chemicals on the concrete.

Canadian Society Elects F. C. Gamble President

At the annual meeting of the Canadian Society of Civil Engineers in Montreal, Jan. 26, 27 and 28, Francis Clark Gamble, chief engineer of the Department of Railways for the Province of British Columbia, was installed as president of the society. Mr. Gamble, who is a native born Canadian, is an alumnus of the Rensselaer Polytechnic Institute, and has been prominent in Canadian railway engineering since 1870. He succeeds Matthew J. Butler.

At the first session the committee on reinforced concrete submitted a report. The members residing in Montreal entertained the visiting members at a luncheon in the Windsor Hotel. The address of the retiring president was delivered in the afternoon, and in the evening a smoker was held in the society's rooms. On Wednesday morning the members visited the new development of the Cedar Rapids Power & Manufacturing Company on the St. Lawrence River, and the Angus shops of the Canadian-Pacific Railway. The afternoon was devoted to reports of the various committees, and the annual dinner was held in the evening.

The report of the Council for 1914 showed an increase of 265 members over the previous year, 3059 being the total present membership of the society.

Urge Engineers for Illinois State Board of Health

Illinois Society of Engineers and Surveyors at Annual Convention Discusses Many Problems Affecting the Welfare of the Profession

A sanitary engineering staff for the Illinois State Board of Health will be created if recommendations made by the Illinois Society of Engineers and Surveyors at the Springfield meeting, Jan. 27, 28 and 29 are adopted. Mr. Drake, secretary of the board, requested action inasmuch as there is continual call for advice on problems relating to sewage treatment, garbage disposal and ventilation, matters which the State Water Survey, the Rivers and Lakes Commission and Natural History Survey do not cover. It was brought out that the efforts of a legislative committee on efficiency to combine the 130 commissions in the State into 12 departments has little chance for successful consummation this year.

Other activities of the society along the line of public questions affecting the engineer were as follows:

A protest was made against engineers in the employ of the State or Federal Government undertaking private work at fees not commensurate with the service rendered. A committee to establish a minimum rate schedule will report at the next meeting.

Inferior concrete materials have been used and aggregates have been imported in large quantities from other States. An increased appropriation, therefore, was urged for the State Geological Survey to enable it to augment its efforts in locating and examining concrete materials in Illinois.

By constitutional amendment a standing committee on legislation was provided for. Its duties will be to watch the course of possible legislation affecting engineers adversely as well as to help in the passage of meritorious bills.

Oppose Waterway Project

An attempt to get the unqualified approval of a \$3,075,000 8-ft. waterway project on the Illinois River, which a special State board of engineers has considered feasible, met with opposition. The committee on resolutions headed by Prof. Ira O. Baker had recommended careful consideration by a committee which was to bring in a report at the next meeting, or sooner if possible. The appointment of such a committee with instructions to report in 30 days was finally recommended.

Thirteen papers on pavements and roads filled the program at two of the five sessions, the sixth session as scheduled on Friday afternoon not being held. W. G. Kirchhoff proposed to pave streets with one gutter only and build that in the center of the roadway. For a 46-ft. width he proposed a 6-in. inverted crown which he asserted would economize as to catch basins, obviate deep gutters for storm flows and necessity for any curbs in residential districts, concentrate the water flow, give an aesthetic appearance to the street, facilitate cleaning, and divide the traffic. So far Mr. Kirchhoff has not built such a street.

Experience with vertical fiber shallow brick covered with a thin asphaltic coat was outlined in a paper by G. E. Johnson, of Fall River, Neb.

A ½-mi. concrete road of exceptional thickness on a 7 per cent grade ascending Marquette Hill, La Salle, was described by B. H. Piepmeier.

Benjamin Jordan presented some interesting facts on the disintegration of macadam roads under dry weather conditions and abnormally heavy loads. He concluded that all the voids down to the base must be filled with screenings well rolled in.

Municipal papers included descriptions of the Springfield water supply, the sewer system of Alton, the selection of deep well pumps and the water supplies of Illinois.

In a description of the South Quincy Levee District, a \$250,000 proposition for reclaiming Mississippi River bottom land at a cost of

\$45 per acre, Edmund T. Perkins, engineer of the project, stated that despite the unusual high cost the bonds had been sold easily at 95. This was due in his estimation to the carte blanche instructions given the engineers to provide for complete internal drainage at the start.

Next year the society will meet at Urbana under the following officers: President, W. S. Shields; vice-president, Paul Hansen; trustees, B. H. Piepmeier and H. L. Fixmer; secretary, E. E. R. Tratman, Wheaton, Ill.

Forty-Foot Waves Smash California Bulkheads and Piers

Waves 40-ft. high, breaking against bulkheads and piers along the coast of southern California on Jan. 30, damaged property to the extent of \$400,000. The greatest destruction occurred at high tide when ground swells from the gale were converted into huge combers. About 1600 ft. of the Standard Oil Company's pier at El Segundo was destroyed, the loss being estimated at \$150,000. One mile of concrete bulkhead and sidewalk at Long Beach, costing \$100,000, and a \$25,000 residence were shattered. The new end of the \$50,000 Windward Avenue pier at Venice, in addition to other piers and buildings, was destroyed. At Redondo half a mile of sidewalk and a score of cottages gave way before the onslaught of the sea; the loss was \$10,000. Five hundred feet of the old Santa Monica long wharf are tottering. At the San Pedro breakwater waves broke an oil main and 600 bbl. of oil escaped into the harbor.

Ready to Build 1¾-Mile Causeway at Corpus Christi, Texas

With contracts let and construction material and equipment already on the ground, work will begin immediately on the causeway which will connect Nueces and San Patricio counties, in Texas. The causeway will be 1¾ mi. in length. It will cross the mouth of Nueces Bay, connecting Corpus Christi with Portland, and forming a link in the highway to San Antonio. The cost of the project is approximately \$165,000. The contractors are W. L. Pearson & Co., Inc., of Houston; Bartlett & Ranney of San Antonio are the consulting engineers representing Nueces County.

One-half mile of this causeway will be of concrete bridging, consisting of seventy-six reinforced-concrete spans and one 35-ft. draw span. The width of the bridge will be 19 ft. between curbs. The remainder of the causeway, 1¼ mi. long, will be a shell fill, with a 40-ft. width at the top and a 120-ft. width at the base. This fill will be protected by riprap and brush mats.

San Patricio County has voted \$50,000 for the construction of the northern approach to the causeway and for connecting roads.

Chicago Has Permanent Railway and Contractors' Exhibit

In order to have a permanent display in Chicago of railway and contractors' supplies one entire floor of the new Lytton Building has been turned over to the Railway & Contractors' Supply Permanent Exhibit. A number of prominent out-of-town companies have rented booth space and make this their exclusive Chicago office. Allen Sheldon is manager.

War Halts Competition for Swedish Harbor Plans

The international competition for plants to enlarge the harbor of Helsingborg, Sweden, has been postponed because of the Swedish mobilization. The German member of the committee for awarding the prizes, R. Weyland, harbor director at Stettin, Germany, is now serving his country in a military capacity and has informed the committee of his inability to be

present at the committee meetings. The program for this competition was announced in the Engineering Record of Jan. 17, 1914, Current News, page 32.

To Allow Railroads to Own Brooklyn Marginal Terminals

Railroad ownership of stock in marginal railway terminals in Brooklyn and Queens, New York City, will become possible if a bill introduced in the State Legislature Jan. 28 becomes law. The fate of the Brooklyn waterfront railway for another year hinges on this bill, as the city lacks the funds to carry out the improvement without help from the railroads. A similar bill was vetoed last year by Governor Glynn.

Boston Drydock in Tangle

Attorney General Attwill of Massachusetts has ruled that the former port directors of Boston had no legal authority to enter into contract for the construction of a drydock in South Boston, although these contracts were ratified by Governor Foss and his council. In his opinion the attorney general concludes that the docks referred to in legislation previously enacted are only those incident to the use of piers. About \$300,000 has already been expended on this drydock. It is expected that the board will either apply for permissive legislation by direct petition, or will report to Governor Walsh asking for a special message on behalf of the project authorizing the completion of the work.

Committee Wants Information on Bearing Value of Soils

Fifty-nine questions relative to the bearing power of soils are asked in a leaflet sent out by the special committee of the American Society of Civil Engineers. Fifteen questions relate to tests of bearing value, thirty-two to data from existing structures and twelve to local practice. In each case the committee desires full information as to time and place, and name and address of person furnishing the information, and also samples of soils described in the data. Information should be sent to R. A. Cummings, chairman of the committee, 221-225 Fourth avenue, Pittsburgh.

Oregon Bill Favors Competition in Paving Bids

A bill will be introduced in the Legislature of Oregon to amend the State road law by requiring that no contracts for constructing State or county highways with hard-surfacing shall be awarded unless specifications for all kinds of standard paving be first adopted so that competitive bids may be received. A resolution declaring for the support of such a measure was offered at the last meeting of the Portland Realty Board.

Six Safety Measures Decided Upon for New York Subway

Six measures to increase the safety of the New York subway have been definitely decided upon, according to a report made to the New York Public Service Commission, First District, by Alfred Craven, chief engineer, whose department has been investigating the subject since the recent subway fire and blockade. There will be required (1) a second telephone system, entirely distinct from the company's present private system, and properly separated from the power cables; (2) an additional lighting system from an outside source, and a rearrangement of the present lighting system, to prevent failure of all lights by a breakdown of one plant; (3) a separate source of power supply for the ventilating fans to be installed so as to be automatically available in case the power from

the substations fails; (4) ventilation from the manholes to the surface of the street, so that smoke and gases will escape through these openings; (5) a thorough and complete segregation of high and low tension cables and lighting and signal cables; (6) increased emergency exit facilities through the ventilating chambers to the street.

Other means for increasing the safety and reliability of the subway are under consideration, but sufficient progress has not yet been made to enable the chief engineer to outline the plans.

Los Angeles Highway Commission Completes \$4,500,000 System

The Los Angeles County Highway Commission which has supervised the construction of 300 mi. of roadway provided for in the bond issue of 1908, has submitted its final report to the Board of Supervisors and asked to be dismissed. The original bond issue was for \$3,500,000, but this was later increased by \$700,000 when the commission secured approval of the change in standard width of macadam road from 16 to 20 ft. Additional money came from premiums in the bonds and as gifts. The members of the commission were David K. Edwards, D. C. Teague and W. A. Gillette.

Court Upholds Miami Conservancy Procedure

Legal obstacles to the formation of the Miami conservancy district, including Dayton, Ohio, and vicinity, were probably removed by the decision on Jan. 27 of the Court of Appeals, holding the writ of error procedure of the petitioners for the formation of the district to be correct and ordering the ten judges of the court of common pleas, sitting as a conservancy court, to take evidence, in accordance with the law, upon the necessity for the formation of the district. The objectors have seventy days within which to carry the case to the Ohio Supreme Court, but since that body on Dec. 15 upheld the constitutionality of the act and, by implication, indicated that writ of error proceedings, and not appeal, were proper in carrying the case above the conservancy court, it is generally believed that the formation of the district will shortly be begun. A majority of the judges of the conservancy court are known to favor the organization of the district.

While the legal obstacles seem thus to be removed, the objectors are working from another direction to stop the plans. They have caused the introduction of a bill amending the conservancy act, which will, if adopted, prevent the carrying out of the plans of the Dayton Flood Prevention Committee, and, further, emasculate the act by making its operation cumbersome. The Dayton plan would be specifically ruled out by forbidding the construction of reservoirs, while directors for the conservancy district would be elected by the affected counties as a whole, instead of by the citizens of the sections to be included within the district. Since the conservancy act is replacing the antiquated ditch laws, many conservancy districts will be organizing, imposing on the electorate the duty of selecting many conservancy directors, whose duties would be local in character and with whom the voters of the county as a whole would have nothing to do.

Michigan Society Would Regulate Practice of Engineering

Resolutions advocating that no engineer be allowed to practice in Michigan unless he is a graduate of an approved school or able to pass a State examination, were referred for action to a committee of the Michigan Engineering Society at the annual meeting of the association in Ann Arbor, Jan. 19-21. Resolutions also were presented urging that the pay of county surveyors be increased from \$4 to \$6

per day. The committee is to report at the next meeting. A resolution urging the State Legislature to accelerate the work of the United States Geological Survey by granting an appropriation sufficient to permit the state geologist to co-operate with the Federal body in Michigan, was adopted.

Among the principal papers presented were the following: "Interstate Water Question" by L. G. Carpenter, Denver; "The Commission-Manager Plan of City Government," by C. E. Chappell, city manager, Jackson; "Failure of Sewer-Pipe Construction in Deep Trenches," by W. W. Brigden, Battle Creek; "The Use of Sulphite Liqueur as a Road Binder," by J. J. Cox, Ann Arbor, and "Cost Data on Concrete Chimney Construction," by K. E. Norton, Coldwater. A joint meeting was held with the Detroit Engineering Society in Ann Arbor, Jan. 20.

The election of officers resulted as follows: President, Delmar Teed, Cadillac; vice-president, George W. Bissell, Michigan Agricultural College; secretary and treasurer, S. J. Hoexter, Ann Arbor; directors, E. C. Rich, Lansing; L. C. Smith, Lansing; T. O. Williams, Grand Rapids.

Indiana Engineers Propose Affiliation of Societies

Some working affiliation between the Indiana Engineering Society and the Indiana Water Supply and Sanitary Association will be attempted in 1916 if the advances of the officers of the former organization meet with favor by the sanitarians. Many individuals are staunch supporters of both organizations, and they feel that the professional interests of both will be materially advanced by a sufficiently close affiliation to avoid duplication of effort, and the expense incurred by members in attending two conventions. The adoption of the means by which the above proposition may be initiated is, to the outsider, one of the most important steps taken by the Indiana Engineering Society at its annual meeting Jan. 21, 22 and 23, in Indianapolis.

This society has adopted the laudable scheme of sending out in advance of its convention such papers and reports as are available. Although this afforded several men the chance to abstract their papers or reports, few of them did so. As a consequence President Albert Smith was confronted with the task of cramming into five sessions the reading of most of the scheduled twenty-nine papers and nineteen reports. The task was successfully accomplished, but not without some lag of interest on the part of the audience.

A proposed engineer's license law and a proposed bill to define the qualifications and compensation of city engineers received some attention, but were referred to the legislation committee when C. C. Brown, chairman, explained that there was no chance for the Legislature now in session to take up either bill.

Reports of the committees, in most cases, consisted of a résumé of the subject for the year with particular reference to Indiana. For example, the water supply committee gave information on the installations in the State of new supplies or new equipment, and then briefly outlined some of the more striking developments.

Valuation, a fruitful source of discussion a year ago, was treated mildly and with little contentious debate, in three papers; W. J. Huddle on "Analysis of Unit Cost," H. O. Garman on "The Computation of a Rate" and A. R. Holliday on "Economic Phases of Valuation Engineering."

The mechanical engineers held sway one whole session, A. E. Ahara, general superintendent of the Dodge Manufacturing Company, giving a masterful exposition of the efficiency movement in machine shop practice. Striking statements with reference to the itinerancy of skilled, as well as unskilled workmen, were received with amazement. The yearly change in the personnel of many machine shop forces exceeds 100 per cent. The same condition obtains abroad.

Prof. W. K. Hatt explained the work of the Indiana Flood Commission and the bill now before the State Legislature to establish a board of control to which will be referred plans for the prevention of and protection from floods. The society later approved this bill and urged its passage.

George E. Martin detailed an interesting traffic census taken on $\frac{1}{2}$ mi. of gravel road on a levee between Lafayette and West Lafayette, over which 27,000 vehicles per week, three-fifths of which were automobiles, passed. Maintenance of the road in good condition by sprinkling and constant attendance to raveled spots, all at a cost of \$150 per month, is a record of note.

Prof. L. W. Wallace detailed experiments on the possibility of fire from locomotive sparks. The maximum number of sparks fall 45 ft. from the center of the track and practically none were collected at 150 ft.

The following officers were elected: President, A. E. Ahara; vice-president, U. S. Hanna; trustees, C. H. Hurd, W. J. Schoonover and Albert Smith.

News of Engineering Societies

The Idaho Society of Engineers held its sixth annual convention at Boise, Jan. 26 to 28.

The Civil Engineers' Society of St. Paul, Minn., held its annual dinner at the Commercial Club Jan. 30.

The Indiana Sanitary and Water Supply Association will hold its eighth annual convention in Indianapolis Feb. 23 and 24.

The Minnesota Surveyors' and Engineers' Society will hold its annual meeting in St. Paul, Minn., Feb. 19 and 20. G. H. Herrold, City Hall, St. Paul, is secretary.

The Brooklyn Engineers' Club, their guests and ladies were entertained by the Brooklyn Union Gas Company on Feb. 4 in its newly equipped gas demonstration building.

The New England Waterworks Association will hold a regular meeting Feb. 10 at the Hotel Brunswick, Boston. Committee reports on meter rates and filter statistics will be discussed.

The Vancouver Branch of the Canadian Society of Civil Engineers at its regular meeting on Jan. 21 heard an illustrated paper on "Street Railway Track Construction" by H. J. Tippet.

The Brooklyn Engineers' Club was addressed Jan. 28 by Robert Grimshaw on organization work. Dr. Grimshaw has spent the last twenty years in Germany on railway organization work, and the paper compared German and American railway systems.

The American Society of Agricultural Engineering at its last annual meeting elected the following officers for 1915: President, H. H. Musselman; first vice-president, J. E. Waggoner; second vice-president, L. W. Ellis; secretary-treasurer, F. M. White.

The National Fire Protection Association, New York Chapter, will hold a meeting Feb. 8, when E. J. Moore, secretary, special committee on Edison Fire of the American Concrete Institute, will deliver an illustrated lecture entitled "The Edison Fire."

The Louisiana Engineering Society at its annual meeting, held Jan. 9 in New Orleans, elected the following officers for the ensuing year: President, L. C. Datz; vice-president, Samuel Young; secretary, W. T. Hogg; treasurer, E. H. Coleman; director, O. K. Olsen.

The Montana Institute of Municipal Engineers at its third annual meeting, held Jan. 19, 20 and 21 at Helena, elected the following officers: President, C. E. Durland; vice-president, C. W. Helmick; secretary-treasurer, C. C. Widener; directors, M. L. Morris and F. C. Snow.

The Virginia Roadbuilders' Association will hold its fourth annual convention at Richmond Feb. 9 and 10. The convention will be addressed by G. P. Coleman, State highway commissioner of Virginia, and by other State en-

gineers. The convention will inspect road and paving work now under construction in Richmond and vicinity.

The Civil Engineers' Club of Seattle, Wash., at its last regular meeting elected the following officers: President, E. B. Hussey; vice-president, C. H. Criswell; secretary, J. T. Dovey; treasurer, H. L. Bushell; members of the executive staff, three-year terms, L. W. Shively, A. L. Bowen and E. B. Crane; two-year term, D. O'Leary; one-year term, R. M. Evans.

The Engineers' Society of Western Pennsylvania, at its meeting in Pittsburgh, Jan. 19, heard an address by E. E. Haslam strongly recommending the Pymatuning reservoir project. The following officers were elected for the ensuing year: President, A. Stuckl; vice-president, Alexander L. Hoerr; treasurer, A. E. Frost; directors, William Hoopes and John S. Unger.

The Cornell Society of Civil Engineers held its tenth annual banquet at the Hotel McAlpin, New York, on Jan. 22. Charles D. Marx, president of the American Society and an alumnus of Cornell, was the guest of honor. Among the speakers were Professor George F. Swain, of Harvard, and James H. Edwards, assistant chief engineer of the American Bridge Company.

The Illinois Society of Engineers and Surveyors held its thirtieth annual meeting at Springfield, Ill., Jan. 27, 28 and 29. Twenty-two papers on various engineering, construction and design topics were presented. Surveying instruments, drawings, photographs and construction materials and equipment were on exhibit. In addition to the annual dinner an automobile inspection trip of Springfield's industries was added to the social side of the program.

The Arkansas Engineering Society at the annual meeting, held Jan. 18 and 19 at Little Rock, elected the following officers for the ensuing year: President, Julius J. Knoch; vice-president, Alfred M. Lund; secretary-treasurer, William J. Parkes; directors, John A. MacCrea and Charles H. Miller. A special committee was appointed to urge upon the members of Congress from the State the importance of an increased appropriation for the Coast and Geodetic Survey.

The American Concrete Institute will hold its eleventh annual convention in Chicago Feb. 9 to 12. The convention will consider the subjects of concrete roads and bridges, reinforced concrete tests and design, concrete in architecture, and concrete plant, management and costs. Among others the convention will hear addresses by C. A. P. Turner, T. A. Smith, of the Turner Construction Company; William P. Anderson, of the Ferro-Concrete Construction Company, and Alfred D. Flinn, of the New York Board of Water Supply. The convention will overlap the eighth annual Chicago cement show, which will be held Feb. 10 to 17.

Personal Notes

Walter E. Skelton has been reappointed city engineer of Salem, Oregon.

Charles J. Bennett has been reappointed State highway commissioner of Connecticut by Governor Holcomb.

John N. Carlisle has been superseded as commissioner of the New York State highway department by Edwin A. Duffy.

Capt. Harold C. Fiske, Corps of Engineers, U. S. Army, is relieved from duty at Pittsburgh and will proceed to Vicksburg, Miss.

Edmund T. Perkins, consulting engineer of Chicago, has been appointed engineer for the Green Bay drainage district in Lee County, Ia.

O. H. Tittman, superintendent of the U. S. Coast and Geodetic Survey, has been elected president of the National Geographic Society.

X. H. Goodnough has been reappointed chief engineer and director of sanitary engineering of the State Board of Health of Massachusetts.

J. R. West has been appointed chief engineer of the Port of Seattle, Wash. He has been for some time acting chief engineer of the port.

Civil Engineer L. F. Bellinger, U. S. N., has been transferred from the navy yard at Portsmouth, N. H., to the naval station at Cavite, P. I.

C. Brannon, assistant engineer of the Chicago & Eastern Illinois Railroad, Chicago, has been appointed division engineer of that road at Evansville, Ind.

R. N. Hudson, general manager of the Louisville & Atlantic Railroad, has been elected president of the Louisville, Henderson & St. Louis Railway to succeed L. J. Irwin, deceased.

B. F. Beckman, superintendent of the Fort Smith & Western and the St. Louis, El Reno & Western railroads, has been appointed engineer of those roads with headquarters at Fort Smith, Ark.

Hering & Gregory, consulting engineers, of New York City, have been retained by the Board of Contract and Supply of Albany, N. Y., to prepare plans for a sewage pumping station for that city.

F. M. Miller, formerly county surveyor of Nevada County, Cal., and city engineer of Grass Valley, Cal., has been appointed to an engineering position with the State Department of Corporations.

James F. Donovan, supervisor of the Lehigh Valley Railroad at Delano, Pa., has been appointed division engineer, with headquarters at Hazleton, succeeding T. J. Burke, who is transferred to the operating department.

Cecil N. Haggart has been appointed bridge and structural engineer to the Lake Erie and Ohio River Canal Board. Mr. Haggart will undertake the preliminary design and estimates for the structural work on this project.

Capt. Warren T. Hannum, corps of engineers, U. S. A., is relieved from duty with the third battalion of engineers at Fort Shafter, Honolulu, and assigned to duty as assistant to the department engineer at Honolulu.

Capt. W. Willing, Corps of Engineers, U. S. Army, is relieved of duty with the First Battalion of Engineers, and at Washington Barracks, D. C., to take effect March 1, and will proceed to St. Louis, Mo., for assignment to duty.

H. Whitford Jones, of the engineering firm of H. Whitford Jones & Company of Cleveland, has been selected by the city of Youngstown, Ohio, to represent the city as arbitrator in connection with the readjustment of lighting rates.

Edward P. Burch, a graduate of the University of Minnesota, who assisted in the recent valuation of the Street Railway Company of Detroit, has opened an office as consulting engineer in the Dime Bank Building of that city.

E. T. Reisler, division engineer of the Lehigh Valley Railroad of Buffalo, has been transferred to Auburn. He is succeeded by L. P. Rossiter, formerly assistant engineer for the Chicago, Rock Island & Pacific Railroad at Manly, Iowa.

George W. Tillson, consulting engineer of the Borough of Brooklyn, New York City, has recently given a course of six lectures on street paving at Harvard University in connection with Professor Geo. C. Whipple's course in municipal administration.

C. K. Clark has been appointed city manager of Tucson, Ariz. Mr. Clark was recently engineer for several of the large water companies of the Imperial Valley. He was for six years division engineer on the Southern Pacific Railroad at Tucson.

H. C. McRae, division engineer in charge of the disposal plant at Black River for the Baltimore Sewerage Commission, has resigned that place to make an investigation of the collection and treatment of sewage in Detroit for the International Joint Commission.

Obituary Notes

Horatio M. Forrest died Jan. 18 at Winnipeg, Manitoba. He was locating engineer on the original survey for the Canadian Pacific Railroad, and was afterward government inspector of railways, and district engineer on the Canadian Northern.

James T. Branchfield, a contracting engineer of Chicago, died at his home in that city, January 22. Mr. Branchfield's early experience was obtained as a member of the engineering departments of the Chicago & Northwestern and Santa Fé railroads. He left the Sanitary District of Chicago about 10 years ago and went into contracting work for himself. He was a member of the Western Society of Engineers.

Civil Service Examinations

California State.—Examination will be held Feb. 19 and 20 for construction engineer, \$1800 to \$2400 per annum, in Sacramento, Los Angeles and San Francisco. Applications close Feb. 13.

Examination will be held Feb. 19 and 20 for civil engineer, \$1200 to \$1800.

Examination will be held Feb. 26 and 27 for engineering draftsman, \$1200 to \$1800.

The last two examinations are to fill vacancies with the highway commission, the department of engineering and the state harbor commission. For full information address the State Civil Service Commission, Sacramento, Cal.

City of Chicago.—An examination will be held Feb. 10 for heating and ventilating engineer, \$1920 to \$2400. The office of the Civil Service Commission of Chicago is Room 610, City Hall.

United States.—The following examinations will be held March 10:

Aid, coast and geodetic survey. Computer, coast and geodetic survey. Copyist topographic draftsman, departmental service. Junior engineer, draftsman, engineering department at large. Topographic draftsman, departmental service. Surveyor, Philippine service. Superintendent of construction, supervising architect's office.

The following examinations will be held April 14:

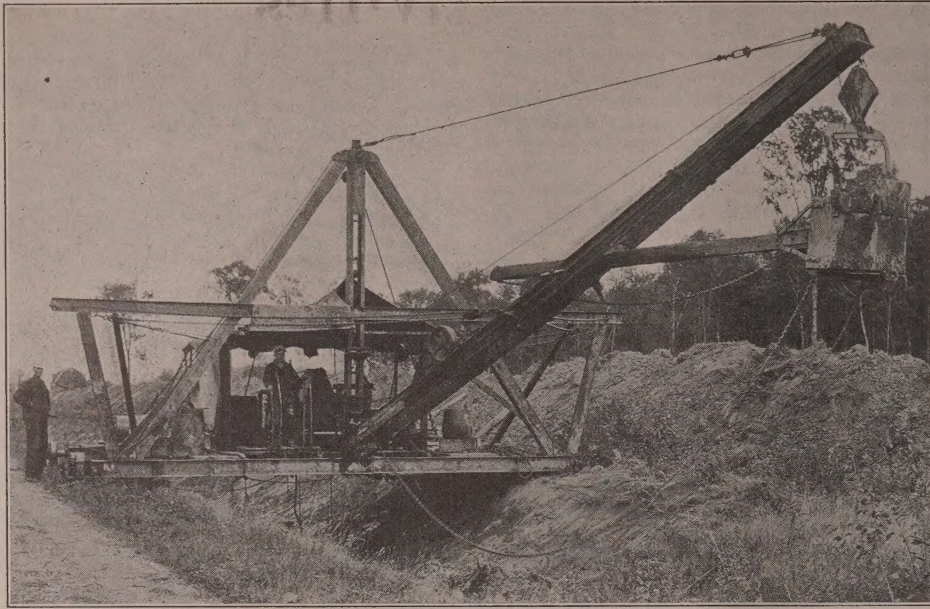
Civil engineer and draftsman. Copyist draftsman, Navy department. Mechanical draftsman, Panama Canal service. Ship draftsman, Navy department. Topographic draftsman, Panama Canal service. Engineer, Indian service.

Application forms and full information may be obtained from the U. S. Civil Service Commission, Washington, D. C., or the secretary of the Board of Examiners at the following named places: Post office, Boston, Mass.; Philadelphia, Pa.; Atlanta, Ga.; Cincinnati, Ohio; Chicago, Ill.; St. Paul, Minn.; Seattle, Wash.; San Francisco, Cal.; Custom House, New York, N. Y.; New Orleans, La.; Old Custom House, St. Louis, Mo.

An open competitive examination is also announced for designing engineer, \$2000 to \$3000 a year. Candidates will not be assembled for examination, but will be rated on education and experience. Five years of irrigation experience are required, of which two years must have been spent in preparing original designs or in reviewing submitted designs for irrigation projects. Persons desiring to take the examination should apply at once for form 1312 to the United States Civil Service Commission, Washington, D. C., or to one of the secretaries of the United States Civil Service Board at the above list of places, and should file his application with the commissioner at Washington prior to the close of March 2.

Examinations Previously Announced

Date.	See Eng. Record.
Feb. 23-27—Assistant engineer and draftsman, city of Philadelphia	Jan. 30
Feb. 24-25—Hull draftsman, United States	Jan. 30

TRENCHING MACHINE WHICH EXCAVATED EARTH FOR $2\frac{1}{2}$ CENTS A YARD

Dry Excavator Handles Dirt at $2\frac{1}{2}$ Cents a Yard

At a rate of nearly 100 yd. an hour, and at a cost of slightly over $2\frac{1}{2}$ cents per cubic yard, the trenching machine illustrated herewith excavated 30,960 cu. yd. in thirty days from a dry ditch near Tuscola, Mich. Twenty-five per cent of the cost figured was for moving the machine to the job and setting it up, and nearly 20 per cent was for laying tracks. For excavating the narrower sections of ditches in open and more or less level ground, this machine should be able to operate almost as cheaply as a floating dredge. One item of saving is in the fuel used, which is kerosene. A feature which saves time is the device for moving the dredge ahead. This is accomplished by means of a chain wound permanently on a separate drum, and fastened by a simple clamp to the track ahead. It is claimed that the operator can move the machine from 6 to 8 ft. and resume digging operations in from 20 to 30 seconds. The track is made in sections, designed to be handled by two men each. The record quoted above was made with a machine owned by Leek & Cooper, contractors of Fostoria, Mich. The excavator is manufactured by Wickes Bros., of Saginaw, Mich.

Hoist a New Feature of Equipment on Tractor

Road and highway bridge builders and contractors are likely to be interested in the latest feature to be added to the tractor—a hoist. Hoisting operations are performed by a drum and niggerhead attachment mounted on the front end of the tractor, which is capable of handling 5000 lb. at a speed of 175 ft. per minute. The new device is being placed on tractors manufactured by the Minneapolis Steel & Machinery Company, Minneapolis, Minn.

Business Notes

The Lehigh Portland Cement Company has removed its New York offices from 261 Broadway to 30 East Forty-second Street.

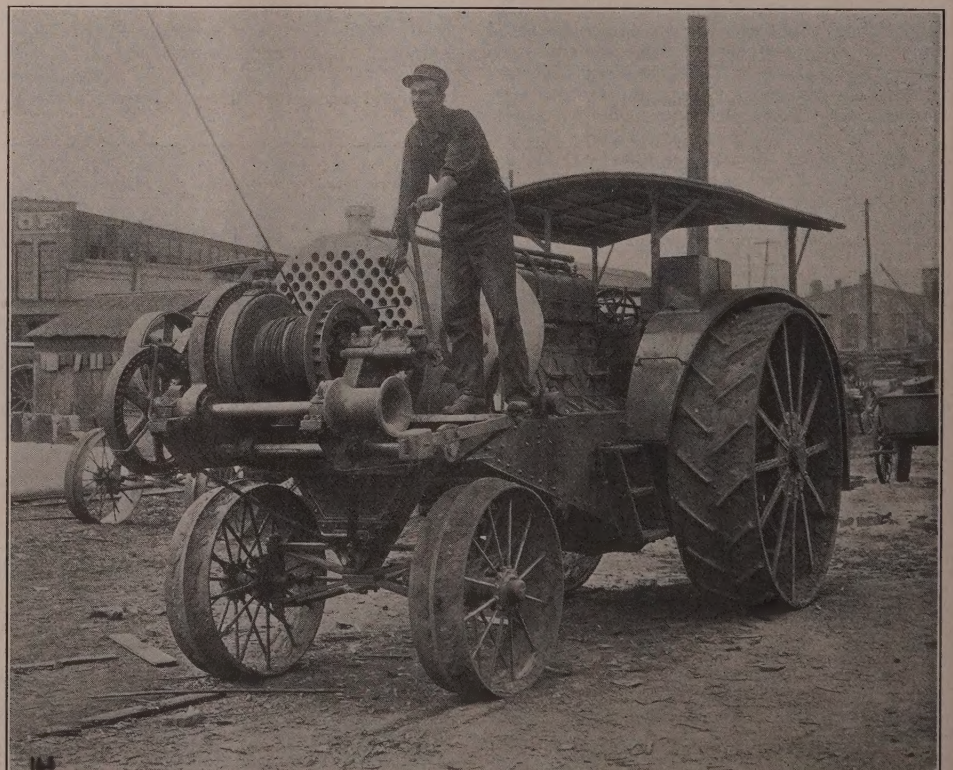
The General Equipment Company, of New York City, has opened a Philadelphia office in the Commercial Trust Building, with E. G. Lewis as manager.

David A. Wright, formerly a Western district manager for the Yale & Towne Manufacturing Company, has opened an office at 140 South Dearborn Street, Chicago, as a

manufacturer's agent, specializing in pneumatic machinery, cranes, hoists and trolley systems.

The Ceresit Waterproofing Company, of Chicago, has established its New York office at 101 Park Avenue. R. E. Clarke is the New York manager.

The Kennedy-Stroh Corporation, of Pittsburgh, has been formed to take over the business of the Kennedy Manufacturing and Engineering Company of New York, the Stroh Steel Hardening Process Company, the Lawrence Steel Casting Company and the Best Manufacturing Company, of Pittsburgh. These companies manufactured mining, dredging, cement making and conveying machinery, steel castings and pipe. The president of the new company, W. H. Schoen, was formerly connected with the Pressed Steel Car Company. J. E. Kennedy, who is chief engineer of the new company, has been engaged for more than twenty years in designing mining and other machinery.



HOIST ADDS TO USEFULNESS OF TRACTOR FOR CONSTRUCTION WORK

Trade Publications

The following companies have recently issued trade publications:

The Lehigh Foundry Company, Fullerton, Pa. Folder 9 x 12 in., 4 pages, illustrated. Describes new design of road scarifier recently patented.

Neptune Meter Company, 90 West Street, New York City. 12-page booklet, $4\frac{1}{4}$ x $6\frac{3}{4}$ in. A brief discussion of the Trident "Victor" water meter.

The Owen Bucket Company, Rockefeller Building, Cleveland, Ohio. Catalog 6 x 9 in., 24 pages, illustrated. Also pamphlet 6 x 9 in., 30 pages, illustrated, describing installations of Owen buckets.

The Pelton Water Wheel Company, Inc., New York and San Francisco. Bulletin 8, 64 pages, showing the adaptability of water wheels to the driving of machinery. The pamphlet contains useful hydraulic data.

Oxweld Acetylene Company, Thirty-sixth Street and Jasper Place, Chicago. Pamphlet 6 x 9 in., 24 pages, illustrated. Describes use of oxy-acetylene welding process in repair and construction work on gas mains, showing steel cutting and welding of special fittings.

Oswin W. Shelly Company, Inc., New York City, has issued a 20-page pamphlet with photographs of buildings of reinforced concrete and other materials which it has constructed. Factory and office buildings as well as dwellings are represented.

Hydraulic Turbine Corporation, Camden, N. Y., Catalog D, 8 x $10\frac{1}{2}$ in., 40 pages with inserted drawings, dealing with water wheels of the Francis type. Contains useful data on the selection of proper hydraulic power equipment with photographs and drawings of turbines, turbine installations and power plants. Tables are given of $H^{3/4}$ for calculating type characteristics; of discharge and speed; of $H^{3/2}$ for calculating horsepower; and for heads due to velocity $h = v^2/2g$. All tables have been prepared by or under the direction of Robert E. Horton. Test report and efficiency and power curves of Holyoke test 2267 are also included in the pamphlet. For the convenience of turbine purchasers is enclosed a loose leaf data sheet with illustrations of various types of wheel settings.